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## THE MEXICAN VOLCANO PARICUTIN<sup>1</sup>

By Dr. PARKER D. TRASK

U. S. GEOLOGICAL SURVEY

THE new volcano in Mexico, El Parícutin (pronounced Pah-ree-koo-teen) is a unique geological phenomenon; for, before our very eyes, it has sprung into existence and has grown to a very respectable height of 1,500 feet, all within a period of 8 months. It lies within a region in which no previous volcanic activity has been known within the memory of man, though in 1759 the volcano El Jorullo, some 50 miles to the southeast, likewise suddenly was born, grew to a height of more than 1,000 feet within 5 months, and then quieted down, never more to erupt violently. Will Parícutin do likewise? That remains to be seen, for at present it is still going strong.

For the first time in their lives geologists have been able to observe in a single volcano all stages of its history. Parícutin exhibits many of the features of

<sup>1</sup> Address presented before the Geologic Section of the New York Academy of Sciences in New York, October 4, 1943. Published by permission of The Director, Geological Survey, U. S. Department of the Interior.

other volcanoes; but other volcanoes have been encountered by geologists after they have been in existence for some time, and their early history is unknown. The early history of Parícutin therefore fills important gaps in our understanding of volcanism.

To me the most outstanding aspect of this volcano is the incredible rapidity with which it grew. Within one week it was 550 feet high and within 10 weeks it was 1,100 feet in altitude. Up to this time, all the material in its cone had come from fragments that had been blown into the air from the volcano. No lava came from the cone until nearly four months after the eruption started; and then, contrary to some popular reports, it did not flow over the lip of the crater. Instead, it broke through the sides of the cone, undermining the overlying fragmental material. Lava appeared within two days of the first explosion, but it issued quietly from a fissure about 1,000 feet north of the explosive vent.

Geologists have been observing Parícutin practically from its inception. Dr. Ezéquiél Ordoñez, the grand old man of Mexican geology, despite some eight decades of age, reached the volcano, together with some associates from the Instituto Geológico de Mexico, within two days of its birth; and he has actively been watching its development ever since. Senor Téodor Flores, director of the Instituto Geológico, has devoted all available facilities of his institution to the study of Parícutin, and the passionate interest he has shown in this volcano would gladden the heart of any scientist.

Dr. William F. Foshag, of the U. S. National Museum, in charge of the war-minerals work of the U. S. Geological Survey in Mexico, has been making a systematic study of Parícutin, and I am indebted to him for practically all statements in this paper not based on my own observations. In addition, many other geologists have visited the volcano. Therefore eventually a rather complete record of its history will be available. I saw Parícutin three times: first, a week after its birth; a second time when it was nearly three months old; and once again, a month later, when I flew over it in an airplane during one of the stages when lava was pouring from the cone.

Parícutin is located in the state of Michoacan, 200 miles in airline due west of Mexico City in the Sierra Madre Occidental, which forms the west boundary of the high plateau that occupies the central part of Mexico. The volcano is situated in an area of forested hills and cultivated lowlands, and the base of the cone lies about 7,500 feet above sea level.

Parícutin is readily accessible. In the early stages an automobile could be driven to the front of the advancing lava flow, but now so much ash has fallen that the only practicable approach is by road to San Juan de Parangaricúti, where horses are available for visitors to the volcano, four miles distant. San Juan is 15 miles by passable dirt road from Uruapan, which in turn is 300 miles by excellent paved road or by rail from Mexico City. Frequent comfortable bus service is maintained between Mexico City and Uruapan, and the ride is one of the most beautiful in the whole world. Good accommodations are to be had in Uruapan and frequent bus service to San Juan is available. Costs are surprisingly low.

Parícutin is located in a region of volcanic rocks consisting of essentially the same andesitic basalt as its own lava. Several hundred volcanic cones lie within a radius of 75 miles of the volcano. These are of all ages; some are so fresh that they can hardly be more than a few hundred or a few thousand years old; others are so dissected by erosion that they must be many tens of thousands of years in age. Most of them are cinder cores—that is, cones composed of

debris blown from a vent in the ground; others are composite cones consisting of both lava and fragmental material. They range in height mainly from 200 to 800 feet. The highest rises some 4,000 feet above the surrounding country. The soil is rich and is derived from volcanic ash and interbedded lava. Most of the cones are conical and have small craters, but a few consist of rings of fragmental material, 200 feet or less in height and some hundreds of feet in diameter. One such abortive cone is situated about one mile northwest of Parícutin; another lies some miles to the east. From the air this latter cone seems to be some 3,000 feet in diameter and less than 200 feet in height. It contains within it, but somewhat off center, a similar ring-like ridge about 1,500 feet in diameter.

The first intimation that something was about to happen was an account in the newspapers about February 12, 1943, that 25 to 30 earthquakes had been felt the previous day near the town of San Juan de Parangaricúti. Each day thereafter increasingly more tremors were reported, and on February 19 some 300 earthquakes occurred. The next day the eruptions started.

Stories of the beginning of the volcano are legion, and as time goes on they probably will become more varied. One of the most colorful is that a farmer while plowing his field turned over a stone, whereupon lava gushed forth and, like the headless horseman in the Legend of Sleepy Hollow, raced down the furrows behind him as he fled. This story of course is fantastic; in the first place, no Mexican would plow a furrow down hill, and in the second place, the Parícutin lava was too viscous to flow rapidly.

The most reliable story is that a farmer, Dionisio Pulido, while plowing noticed a column of smoke about three inches in diameter spiralling upward from a small hole in the middle of the field. Thinking that he had inadvertently started a fire he went over to the smoke and put it out by placing a stone over the hole. He continued plowing and sometime later looked around and saw smoke emerging from the ground in greater force. He went forthwith to inform the Presidente of the town of San Juan, who sent a group to see what was happening. Upon arriving at the spot three hours later these people found a hole some 30 feet in depth from which dense clouds of dark smoke were issuing. About ten that night, February 20, the first explosion occurred, and since that time the volcano has been erupting steadily.

When I first visited the volcano, on February 28, a little over one week after its inception, the explosions were coming at fairly regular intervals of 4 seconds. At times two explosions would come in quick succession; at other times the interval between outbursts was 6 or 8 seconds. In general the explosions were

of about equal force, though occasional loud outbursts occurred. One was strong enough to knock me off balance while walking some 3,000 feet from the crater.

The sound from the explosions seemed to originate within the crater at about the level of the ground, though occasional explosions took place in the ash cloud 500 feet above the top of the cone. Each explosion from the crater acted like a giant gun-burst. The material was ejected from the throat of the volcano in a cylindrical column to a height of 400 to 800 feet above the top of the volcano, and at this point, like water in hydraulic jump, suddenly formed dark expanding cumulus clouds of ash that billowed upward to a height of 6,000 to 8,000 feet above the ground, where steam would begin to condense. With increasing altitude the ash cloud became progressively whiter with water vapor until some 10,000 to 12,000 feet above the ground, where it was nearly pure white. The column of vapor continued upward to about 15,000 feet and was carried eastward in a horizontal cloud bank from which columns or large puffs of vapor curled upward for another 2,000 or 3,000 feet, like ostrich plumes sewed tandem on an ermine scarf.

At this time the material ejected from the crater was thrown upward at an angle deviating from the vertical by  $10^\circ$ , much as if it were coming from a sharply defined conduit. As a result of this inclined direction of outburst, more material fell on the west side of the cone than on the east, thus causing the top of the cone to be lopsided. In the course of four hours the angle of ejection changed gradually back to vertical and two hours later was deviating 5 degrees to the east, thus causing the east side of the cone to build up faster than the west side.

The column of ash ascended nearly vertically but was deflected slightly eastward by the wind. Trains of cinders, one-eighth to one-half inch in diameter, rained down from the ash clouds on the lee side of the cone. They were cool, light and very porous, and they sounded like sleet as they fell on one's hat. Few cinders were falling more than two miles from the volcano. At this distance the ground was just barely covered by them. Fine particles of ash were transported greater distances than cinders, and covered the country side in delicate films for as much as 15 miles away on the leeward side. The ash and cinders were 18 inches thick 500 feet from the edge of the cone, which was the closest to the volcano my courage permitted me to approach.

At this point the ground was pock-marked with pits three to five feet in diameter where large fragments or bombs had buried themselves in the ground. The average distance between bomb-pits at this point was about 20 feet. During some 30 minutes while I was standing there, two bombs fell within 300 feet. One

bomb more than four feet in diameter landed 25 feet away. For awhile as it was coming down it looked as though it might make a direct hit, and the problem was which way to run, but eventually it veered slightly and the next moment it came down with a large whoosh and whistle, and buried itself. The top was about one foot beneath the surface of the ground. A piece broken from it was hot enough to light cigarettes. Another bomb two feet in diameter, landed 50 feet to the rear, breaking an oak limb eight inches in diameter, much as if it were a cleaver cutting a bone. This bomb buried itself three feet in the ground. It came down five feet from some girls, who immediately retired to a more discreet distance.

Most of the fragmental material ejected from the volcano in this stage of its history consisted of bombs, rather than of ash or cinders. With each explosion the bombs were blown 2,000 to 3,000 feet into the air. Most of them landed on the cone; the greatest distance at which I found a bomb was 3,500 feet from the center of the volcano. The bombs went so high that it took from 10 to 15 seconds for most of them to fall, after they had reached their greatest height. They were roughly spherical and ranged in size from a walnut to a big house. Most of them were between three and five feet in diameter. The largest I saw was a block 50 feet in diameter, which was blown 300 feet above the top of the crater; that is, 850 feet above the ground. Nearly all the bombs when they landed were so thoroughly solidified as not to change in shape, though many when they struck the sides of the cone, broke into pieces. A few were still liquid when they landed and splattered out like pancakes on the ground. Bombs of this type did not penetrate the earth for more than three inches. Others rotated slowly in the air, gradually thinning in the middle, and before they fell separated into two tear-shaped bodies. Some, after coming to rest on the cone, smoked for a considerable time, certainly for as long as 15 minutes. Most of the bombs consisted of highly vesicular basalt, but a very small proportion were composed of a light medium-grained granitic rock that looked like diorite. These granitic rocks were angular, and not vesicular. They evidently were blown from the conduit through which the lava was coming.

Most of the bombs landed upon the sides of the cone, ricocheting down the side until they came to rest. The sides of the cone were remarkably even and were at an angle of  $33^\circ$  with the horizontal. The volcano at this time was 550 feet high and 1,700 feet in diameter at the base. The diameter of the crater at the top of the cone was 250 feet, and the orifice from which the material was ejected seemingly was about 75 feet in diameter.

The volcano at night is a magnificent, never-to-be-

forgotten sight. Nearly all the bombs that are blown from the crater are red hot, and they shower up like a gigantic Fourth-of-July flower-pot. The floral effect is complicated by the fact that four or five subsequent explosions have taken place before the bombs from any one explosion have all landed. Thus some bombs are going up, some are just arching over at their highest point, and others are falling. After the bombs strike the sides of the cone they cascade down in great fiery arcs. Some come to rest on the sides; others roll to the bottom. The glow from the cone comes and goes, depending upon the number of bombs that fall and the interval between explosions. Big outbursts cover the whole volcano, and the cone progressively lightens up in an ever larger descending curtain of fiery red, as the fragments land progressively down the sides of the cone. Then, as the bombs cool, the red gradually darkens. Yet before the color finally vanishes another crop of bombs falls and the scene is repeated. Even though parts of the cone may fade into darkness before a succeeding increment of glowing bombs descends, a ring of red always remains around the edge of the cone where the rocks that roll completely down the sides come to rest.

A flow of lava first appeared in a plowed field about 1,000 feet north of the crater about two days after the birth of the volcano. In five days it had attained a length of 2,000 feet, a width of 600 feet and a thickness of 20 feet at the sides and front. It continued to grow for about 6 weeks until it was about 6,000 feet long, 3,000 feet wide and more than 100 feet high. The front and sides were steeply inclined; the top was nearly flat and consisted of blocks of congealed scraggly aa lava 3 to 15 feet in diameter.

At the time I saw the lava, five days after it first appeared, it was flowing westward down a gently sloping field at a rate of about three feet an hour in front and one foot an hour on the sides. Like a glacier the lava moved most rapidly in direction of greatest slope, and like a glacier it also developed pressure ridges as it flowed. It advanced by pushing large blocks of solidified lava, three to five feet in diameter, off the front and sides. These blocks fell down the edges of the flow, and in turn were covered by other blocks similarly spalled by the advancing lava. Gradually the molten rock inside the flow passed over the fallen blocks and incorporated them within itself, forming a volcanic flow breccia. At all times the surface of the lava was congealed, except for places from which blocks had broken off at the edges of the flow as the lava advanced. These freshly exposed places consisted of red, pasty, dense lava that solidified within a few minutes to hard rock.

Fumaroles came out of vents 6 inches to a foot in diameter and gave off dense clouds of white smoke,

which, according to Foshag, is largely ammonium chloride. The ammonium chloride also condenses in a white powder around the orifices of the fumaroles, and in places a fringe of bright-orange iron chloride is also formed. Few poisonous gases seemingly are given off.

When I visited Parícutin the second time, about the middle of May, nearly three months after its birth, it was still erupting at about the same rate, but the explosions were less forceful and a much larger proportion of ash was coming out. The cone had doubled in height and the orifice from which the material was being ejected seemed to be about 150 feet in diameter. Ash was everywhere, and most of the trees within 5 miles of the volcano had been killed. The lava flow had stopped moving and was covered by 6 to 8 feet of ash. Even at Uruapan, 15 miles east of the volcano, the ash was 6 to 8 inches thick, and at San Juan, four miles to the west, it was 15 inches thick. A large part of this ash fell in one period of 36 hours early in April. Electrical discharges or lightning strokes were flashing at irregular intervals, sometimes as frequently as 30 an hour. These flashes were vertical in the cloud of ash, and generally started within a few hundred feet of the top of the cone. They ranged in length mainly from 500 to 1,500 feet, and produced sharp cracks but no loud thunder.

About four weeks after this visit, a phase of lava actively ensued. In the course of a week, 8 flows appeared, all from within the cone. Prior to this time, that is, for almost four months, no lava had come from the cone itself and there had been just the one flow. According to Foshag, each flow was preceded by a period of violent explosive activity, which terminated shortly before the lava came. While the lava was issuing from the volcano relatively few explosions took place. All these flows ruptured the sides of the cone, and those that came from the upper part of the volcano undermined the fragmental material above, leaving a large gap in the side of the cone. These gaps were rapidly filled by material blown from the crater after the lava ceased to move. One flow advanced in three days as far as the town of Parícutin, three miles to the west. When it approached Parícutin it was moving at a rate of about 100 feet an hour. Another flow on the east side of the cone spread out like a large fan at the base of the volcano. According to Foshag, this one went 1,500 feet in 15 minutes.

While one of these flows was in progress, I had the good fortune to fly over the volcano. At this time the crater was nearly full; lava extending to within 50 feet of the lip. The top of the lava in the crater was congealed, and was broken in large blocks. Ashes were issuing from a vent estimated to be 75 to 100 feet

in diameter in the northwest part of the lava field within the crater, but relatively few explosions were seen. Lava was flowing from an opening on the east side of the cone. This vent was 50 to 75 feet in width and 200 to 300 feet in height. The upper limit was 100 to 150 feet beneath the lip of the crater. The lava coming through the opening was red hot, but it soon cooled and congealed while flowing down the sides of the volcano. The cone was intact above the point of

escape of lava, but according to Foshag it subsequently was undermined by the flow.

At this time, June 19th, Parícutin was 1,200 feet in altitude. By late September it had reached a height of 1,500 feet. At that time it was still exploding at about the same rate as when it started, and was showing no signs of dying. In the meantime several other flows of lava had appeared, mostly from within the cone. Parícutin truly is now a full-fledged volcano.

## PRESENTATION OF THE SEDGWICK MEMORIAL MEDAL

THE Sedgwick Memorial Medal of the American Public Health Association was presented at the seventy-second annual meeting on October 12 to Brigadier General James Stevens Simmons, U. S. A., director of the Preventive Medicine Division of the Office of the Surgeon General, U. S. Army.

The medal was established in memory of William T. Sedgwick, of the Massachusetts Institute of Technology, pioneer teacher of public health in the United States. It is awarded for distinguished service in public health. The following have received the award in the past:

1929	Charles V. Chapin
1930	Theobald Smith
1931	George W. McCoy
1932	William H. Park
1933	Milton J. Rosenau
1934	Edwin O. Jordan
1935	Haven Emerson
1936	Frederick F. Russell
1938	Wade H. Frost
1939	Thomas Parran
1940	Hans Zinsser
1941	Charles Armstrong
1942	C.-E. A. Winslow

Dr. C.-E. A. Winslow, of the School of Medicine of Yale University, made the presentation address, which was followed by an address of acceptance by Brigadier General Simmons.

### PRESENTATION ADDRESS OF DR. C.-E. A. WINSLOW

SHORTLY after the close of the first World War a distinguished British orthopedist was presented for an honorary degree at Yale with the statement that "no man has contributed more than he to the upright position of Britain during the recent war." The Sedgwick Medal is this year awarded for somewhat similar reasons. The 1943 recipient of this medal has done more than any other single individual to make the science of public health effective in maintaining the manpower which our nation has mobilized for the defense of freedom.

James Stevens Simmons was born at Newton, N. C., in 1890. He took his M.D. at Pennsylvania in 1915

and in 1916 entered the Medical Corps as a first lieutenant. For more than a quarter of a century he has devoted his life to the upbuilding of public health laboratory service in the military establishment. In an Overseas Unit in 1918, at the Walter Reed Hospital, in Honolulu and Manila, on the Canal Zone and in the Army Medical School he contributed materially to sound laboratory practice and in 1935 edited a valuable volume on "Laboratory Methods of the U. S. Army." He has made significant original contributions to our knowledge of malaria, and encephalomyelitis and other insect-borne and virus diseases.

With the outbreak of the present war, Colonel Simmons (now Brigadier General Simmons) was entrusted with the organization of a Division of Preventive Medicine in the Office of the Surgeon General. To his energy and vision, to the inspiration of his open and generous and affectionate personality, goes the chief credit for an astounding record of creative initiative and administrative efficiency. The creation of a Board for the Investigation and Control of Influenza and other Epidemic Diseases in the Army (including the most eminent experts in all related fields); the appointment of a distinguished headquarters staff; and the despatch of highly qualified commissions to points of danger all over the world—these have been the instruments in planning a health program of global extent with a record of phenomenal achievement. Operating in some of the most deadly swamps of the world, in regions where malaria and typhus fever and dysentery have for centuries reigned supreme, our army has functioned with a relative freedom from disease unprecedented in military history. At home, the success with which venereal infections have been held in check is equally notable; and, so far, the Army has suffered no serious disability from any of the upper respiratory diseases.

The record to date has constituted one of the finest chapters of achievement in the whole glorious century of modern public health. We do well to honor General Simmons as the central inspiration of this achievement; and in honoring him we pay tribute to the Army of the United States, which has proved itself as effi-

cient by the bedside and in the laboratory as on the beach-heads of the Pacific and the Mediterranean.

Professor Sedgwick, in whose memory this medal is awarded, devoted his life to the application of science in the service of the state. He would hail this outstanding example of such application. One of his last major addresses was delivered during the first World War under the title "From Peace to War, from War to Victory, from Victory to Just Judgment." He would exult that public health science has, through General Simmons, made so important a contribution to the completion of the task which we left unfinished twenty-five years ago, but which we now propose to push on to completion.

ADDRESS OF ACCEPTANCE OF BRIGADIER GENERAL  
JAMES STEVENS SIMMONS

Mr. President, Dr. Winslow, fellow Members of the American Public Health Association, Ladies and Gentlemen:

I appreciate deeply the great honor which you have shown me and the Medical Department of the Army, by this public expression of your approval of our efforts in the fields of military preventive medicine.

Your gracious invitation to attend this meeting and receive the Sedgwick Memorial Medal, reached me by radio a few weeks ago at our military headquarters in New Delhi, where I had arrived after surveying the Army's health activities in the European, North African and Middle East Theaters. Naturally it came as a welcome surprise. As I flew back over the long air highways to join you, I experienced a feeling of deep satisfaction and humble appreciation. My pleasure was in part personal, but I was even more pleased with your recognition of the medical department's achievements in the prevention of disease.

The far-flung forces of the U. S. Army are now scattered throughout many parts of the world where they are exposed to a great variety of crippling diseases. In some of these areas—especially in combat zones, the incidence of certain infections has at times been a matter of concern, but considered as a whole the health of our troops has been remarkably good. In fact, during this war the incidence rates for many serious diseases in the Army have been lower than at any time since the battle of Lexington.

This remarkable triumph in military preventive medicine can not be ascribed to any single person or

organization. It has resulted from the combined effort of all the health agencies of the nation functioning as a finely coordinated, efficient team, united for war. The Surgeon General of the Army has been responsible for the establishment of an effective health program, and the officers of the Medical Department have carried it out. However, at every step in the development and execution of this program the Army has received and utilized the advice and assistance of the entire public health profession of the United States.

Advantage has been taken of the existing large fund of information concerning the control of disease; and, when indicated, studies designed to improve old control methods or to develop new ones have been undertaken. The U. S. Public Health Service working through state and other health agencies, has carried out an enormous program of extra-military sanitation and disease control in order to protect troops from infectious diseases occurring in the civil population. The National Research Council, the Committee on Medical Research, the Department of Agriculture and other governmental agencies have contributed materially to the Army's health program. Innumerable civilian agencies and scientific organizations, particularly the American Public Health Association, have played an active role in furnishing a host of scientific advisers and investigators who have helped the Army in the solution of its many health problems.

I regret that I did not have the privilege of knowing Dr. Sedgwick and of working with him. I am sure that it is the deep regret of all who are assembled here that he is no longer with us in person. However, we have a keen sense of his being here in spirit and believe that he must take profound satisfaction in knowing that many of the advances which have been made in the prevention of disease in the Army are due to his vision and influence. These achievements are the outcome of the development of basic principles established by this great pioneer in public health and preventive medicine.

Again I wish to thank you for selecting me to receive the Sedgwick Medal. I am delighted to accept it with the full realization that in so doing I am only acting as its custodian for the Medical Department of the Army and for the health workers of the United States.

## OBITUARY

### ELMER DARWIN BALL

ON October 5, 1943, in Pasadena, California, there passed from life a well-known scientist and administrator, whose scientific career had been brought to an

abrupt termination more than five years earlier, when Dr. E. D. Ball, in February, 1938, suffered a cerebral hemorrhage at his home in Tucson, Ariz. Since then he had been on extended leave from the University of

Arizona, where he was professor of zoology and entomologist of the Agricultural Experiment Station.

Elmer Darwin Ball was born in Athens, Vt., on September 21, 1870, the son of Leroy A. and Mary A. (Mansfield) Ball. The family removed soon after to Iowa, with which state Dr. Ball was identified during his early life and the beginning of his career. In 1899 he married Mildred R. Norvell, who survives him.

In the public schools of Iowa and Iowa State College he received his early education and teaching experience, receiving the B.S. and M.S. degrees from the college in 1895 and 1898. After teaching in the common schools of his state and serving a year as assistant principal of Albion Seminary, he began his scientific teaching career as assistant in zoology and entomology at his alma mater, transferring from there to a similar position in the Colorado Agricultural College in 1897 for four years. Next he accepted a professorship in the Utah Agricultural College and completed, during this period of his career, his graduate work under guidance of Professor Herbert Osborn, becoming a specialist in the leafhoppers and related families and receiving the Ph.D. degree from Ohio State in 1907. He has been for years an outstanding authority on the taxonomy of these groups of insects.

In 1907 also he was appointed to be dean of the Utah Agricultural College and director of the Experiment Station, and it was while he served in this capacity that the writer first met him and formed a friendship of many years standing. He could always be counted upon for support of local scientific organizations, as well as national, as evidenced by his holding membership in the Academies of Science of Iowa, Ohio, Utah, Wisconsin, California and Washington, D. C., in addition to the usual memberships in professional organizations.

In 1916 Dr. Ball became state entomologist of Wisconsin, but after two years returned to teaching as head of the department of zoology and entomology at Iowa State College. Since this position entails also the duties of state entomologist, teaching may have been largely curtailed by administration. The last two years of his incumbency at Iowa State he was on leave to serve as assistant secretary of agriculture under secretaries Meredith and Wallace. From 1921 to 1925 he was director of scientific work in the U. S. Department of Agriculture. Here he backed legislation raising salaries of scientific workers in the department to enable it to obtain and hold better research men.

From 1925 to 1928 Dr. Ball was in charge of celery insect investigations for the Florida State Plant Board. The resulting publication by Ball and co-workers is outstanding in its emphasis on the ecologi-

cal phases of the problem, and shows in fact that the celery leaf tier is effectively prevented by ecological conditions from doing damage most years and that artificial control is only occasionally necessary and can be anticipated in time to prepare.

In the fall of 1928 he became dean of the College of Agriculture and director of the Agricultural Experiment Station of the University of Arizona, and in 1931 transferred again to teaching and research in the position held at the time illness overcame him.

Dr. Ball throughout his career was known as an indefatigable investigator. In Utah he pioneered in development of the driving spray method of codling moth control, did the genetics work on a long-time poultry breeding experiment, and first clearly recognized and pointed out the probable transmission of curly top of sugar beets by the beet leafhopper, later proven, and now unquestioned. The third discovered instance of insect transmission of plant disease, tip-burn of potato, was first suggested by him. While in the Wisconsin work, he suggested and organized methods of eradication of American foul brood of bees and in Arizona engaged in a major project on range grasshoppers.

Throughout his career he used every possible hour and vacation period in collecting and taxonomic study of those small but often economically important little insects known as leaf-hoppers, tree-hoppers, frog-hoppers and some related forms. His unrivalled private collection of these insects is now a part of the National Museum collection. His contributions number some two hundred papers, of which over one hundred are taxonomic, more than sixty economic, and the remainder in general science and administration.

Dr. Ball was an enthusiastic teacher, helpful with counsel and financial assistance to worthy students. The writer has known him as a colleague in scientific organizations, as a dean and director, and finally as a member of the writer's department and in all these capacities as a cheerful co-worker and loyal friend.

CHAS. T. VORHIES

#### DEATHS AND MEMORIALS

DR. MALCOLM D. BRODE, professor of zoology at the University of South Carolina from 1927 to 1929 and at Beloit College from 1929 to 1935, lost his life on November 1 in a fire at Berkeley, Calif. He was forty-three years old.

LIEUTENANT CHARLES F. BOWERS, on leave as professor of architectural engineering at Iowa State College, is reported to have lost his life on October 21 in an airplane accident in the South Pacific.

PROFESSOR ROLLAND D. FOX, associate professor of bacteriology at the University of Akron and director

of the laboratories of the health department of the city of Akron, died on October 24 at the age of forty-four years.

DR. ARMIN V. ST. GEORGE, associate professor of pathology at the New York University School of Forensic Medicine and since 1916 assistant director of the laboratories at Bellevue Hospital, died on November 20. He was fifty-one years old.

EARLE R. PICKETT, since 1929 chief chemist for the Beech-Nut Packing Company, died on November 6 at the age of forty-seven years.

RALPH N. MAXSON, for thirty-seven years a member of the department of chemistry of the University of Kentucky, died on November 18. A correspondent writes: "His first diploma was granted him at Rhode Island State College in 1902. He received his Ph.D. from Yale University in 1905 and became affiliated with the University of Kentucky in 1906. In 1907 he was made assistant professor; in 1909 professor of inorganic chemistry. He became head of the department of chemistry in 1934, but in 1942 he resigned that position and resumed his former title of professor of inorganic chemistry, a position he held until his death. Dr. Maxson was a member of the American Chemical Society since 1910, the American Association of University Professors, the Society of Sigma Xi and Pi Gamma Mu, and the Kentucky Educational Association."

THE REVEREND FATHER GILLET, director of the Botanical Garden of Kisantu, Inkisi, Belgian Congo, Africa, died on July 22. He is succeeded by his assistant, the Reverend F. L. Gorissen.

THE death at the age of sixty-three years is announced from Moscow of Dr. Sergio I. Spasokukotey, the well-known surgeon, a member of the Academy of Sciences of the USSR, who a short time ago received the Joseph Stalin Award.

*Nature* reports the death of Dr. H. L. Lebesgue, For. Mem. R.S., during 1941 professor of mathematics in the Collège de France, at the age of sixty-eight years, and of Professor Einar Lönnberg, the well-known Swedish zoologist.

It is reported in the *Journal* of the American Medical Association that a bas-relief portrait of Dr. James B. Herrick, for many years a member of the staff of Presbyterian Hospital, was presented to the hospital during special exercises on November 6 commemorating the sixtieth anniversary of the hospital, the fortieth anniversary of the founding of the School of Nursing and the one hundredth anniversary of the admission of the first students to Rush Medical College. The portrait was presented on behalf of the associates of Dr. Herrick by Dr. Ernest E. Irons, formerly dean of the college.

THE *S. S. Victor C. Vaughan*, launched at Portland, Oregon, on September 12, was named in honor of the late Dr. Vaughan, dean of the Medical School of the University of Michigan. The name Victor C. Vaughan was given on Federal order. Dr. Vaughan was one of several distinguished American men of medicine named by a special commission delegated to select the men to be so honored. *The Michigan Alumnus*, in the issue of October 23, records the naming of the Vaughan General Hospital, a new unit of the Army's system of hospitals.

A LIBERTY ship named in honor of Charles H. Herty, formerly editor of *Industrial and Engineering Chemistry* and in 1915-1916 president of the American Chemical Society, was recently launched.

THE Spanish Cultural Institute at Buenos Aires has dedicated a histological laboratory to the memory of Ramon y Cajal. It is under the direction of Professor Hortegan.

## SCIENTIFIC EVENTS

### THE PROPOSED DEVELOPMENT OF WAYNE UNIVERSITY

CITIZENS of Detroit and Wayne County have formed a corporation for the construction of the first units of the projected \$50,000,000 Medical Science Center of Wayne University.

The announcement was made by Wendell Anderson, chairman of the Citizens' Executive Committee, which has had the project in charge since the Board of Education adopted a resolution pointing out that the program of the Medical Center had "progressed to a point requiring more formal organization." The resolution went on to request the incorporation.

The corporation will be called "The Medical Science Center of Wayne University." Its first board of directors, as designated in the resolution, will be Wendell Anderson, Dr. Warren E. Bow, George R. Fink, Charles T. Fisher, Jr., Frederick J. Gartner, Elmer P. Grierson, Ormond E. Hunt, E. Edwin Hutchinson, George W. Mason, Henry Meyers, Dr. Edgar H. Norris, Dr. Burt R. Shurly and Fred M. Zeder.

The corporation will have full charge of planning, developing and equipping the Medical Science Center, and will raise money for these purposes. When completed, individual units will be turned over to Wayne University, which will then own and operate them.

The Board of Education has approved a site for the first unit. Three blocks are to be used as a site for the Wayne University-County Hospital. Construction of the hospital should begin within a year. In addition to the three blocks to be acquired immediately, the board recommended that the adjacent district with a gross area of 53 acres, be earmarked for the future development of the center. The entire site has the recommendation of the City Plan Commission, the trustees of the Wayne University-County Hospital, the board of directors of the new Medical Science Center Corporation, and the administrative officers of the university.

Tentative plans for a new historical and industrial museum were shown to representatives of Michigan historical organizations at a meeting held on November 19. The plans were drawn up by William E. Kapp, president of the Detroit Chapter of the American Institute of Architects. Speakers at the meeting included L. Hubbard Shattuck, director of the Chicago Historical Society, and Dr. David D. Henry, executive vice-president of Wayne University. George W. Stark, president of the Detroit Historical Society, announced that Mrs. Charles B. Pike, of Chicago, had given to the society the sum of \$50,000 to assist in financing an auditorium in memory of her father, General Russell A. Alger, to be known as the General Russell A. Alger Military Memorial Hall. The auditorium will form a part of the proposed museum. A condition of the gift provides that, within eighteen months of the signing of the trust agreement, an additional \$200,000 must be raised to further the project.

### RARE CHEMICALS

THE following chemicals are wanted by the National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Dearborn and Federal Streets, Chicago, Ill.:

1-Amino-4(4-aminophenylamino) anthraquinone  
Bituminous Shale Oil  
Cytosine  
Beta hydroxy glutamic acid-d  
Methyl isopropenyl ketone  
Morin (pure)  
Neopentane (pure)  
Potassium salt of tetrabromphenolphthalein ethyl ester  
Titanium hydride  
Silver fluoride  
beta-amyrin  
Tetra butyl lead  
Triphenyl lead hydroxide  
Tritolyl lead hydroxide  
Tributyl lead oleate  
Tributyl lead ricinoleate  
Tetraphenyl tin  
Tetra butyl tin  
Triphenyl tin hydroxide

### THE SUGAR RESEARCH FOUNDATION

A LONG-RANGE program of research on sugar will be undertaken at the Massachusetts Institute of Technology in cooperation with the newly established Sugar Research Foundation of New York, which has made a grant of \$125,000 for a five-year program of research. Plans for the project were made public in a joint announcement by President Karl T. Compton, of the Massachusetts Institute of Technology, and Joseph F. Abbott, president of the Sugar Research Foundation.

The foundation was established for the development of fundamental knowledge in the field of carbohydrate chemistry, biochemistry and nutrition. Membership is open to all producers and processors of sugar in the United States, Puerto Rico, Hawaii and Cuba.

Dr. Compton, in announcing the cooperative arrangement, said:

The new program is another step in the institute's long-established policy of cooperation with industry in fundamental research to improve industrial processes and develop new products. The project we are about to undertake is a pioneering plan of national significance in that it promises substantial benefits, not for one organization, but for an entire industry.

The rewards of scientific research in cooperation with industry are by no means restricted to the development of new products, for the discovery of new knowledge in any branch of science invariably proves to be a contribution to advanced technical education in associated fields. Thus this sponsored research on sugar makes it possible for the institute to continue and expand the program of fundamental investigations in the field of carbohydrate chemistry which has been in progress for several years.

We are particularly glad that Dr. Robert C. Hockett, who has been given leave of absence from our faculty to become the scientific director of the Sugar Research Foundation, will be in charge of this broad program.

The sugar industry is to be commended for its public service and vision for making possible this objective research. I feel sure it will be rewarded by results of great scientific value to the public.

Commenting on the new laboratory, Joseph F. Abbott, president of the Sugar Research Foundation, said in part:

It is anticipated that the chemical studies conducted under the arrangement with the Massachusetts Institute of Technology will not only extend knowledge of the role of sugar and other carbohydrates in the human body, but also will unfold wholly new industrial uses for sugar and its derivatives. It is our hope that the collaboration between the industry and this outstanding technical institution will prove to be of great benefit to science and the general public as well as to the industry.

An important objective of this broad research program will be the training of scientists in the field of carbohydrate chemistry to prepare them for service in the industry for further technical studies. Provision has also been

made for fellowships for young graduate students who are candidates for advanced degrees to permit them to continue their work in this field.

### THE ALABAMA ACADEMY OF SCIENCE

THE new officers for the Alabama Academy of Science for 1943-44 are: *President*, Dr. E. V. Jones, Birmingham-Southern College; *President-Elect*, Dr. James T. MacKenzie, American Cast Iron and Pipe Company; *Secretary*, Winnie McGlamery, Alabama Geological Survey, University; *Councilor of the American Association for the Advancement of Science*, Dr. Septima C. Smith, University; *Councilors of Junior Academy*, Dr. Alvin V. Beatty, University; Miss Kathryn M. Boehmer, Birmingham; *Section Chairmen*: Biology and Medicine, Dr. J. M. Robinson, Alabama Polytechnic Institute; Chemistry, W. C. Frishe, Alabama Polytechnic Institute; Geology and Anthropology, Peter A. Brannon, Department of Archives and History, Montgomery; Geography and Conservation, Miss Lillian Worley, Alabama College, Montevallo; Physics and Mathematics, Dr. G. F. Barnes, Judson College, Marion; Industry and Economics, Roy Goslin, Alabama Polytechnic Institute; the Teaching of Science, Dr. J. L. Kassner, University.

The Alabama Academy of Science did not hold the usual spring meeting in 1943, which was scheduled at Auburn. Instead there was a called meeting of the executive committee during the latter part of April in Birmingham, at which time it was decided that the 1944 spring meeting of the academy would be held in Birmingham, the date to be determined later.

WINNIE MCGLAMERY,  
*Secretary*

### AWARDS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE American Society of Mechanical Engineers conferred its 1943 honors and awards at the dinner program of its sixty-fourth annual meeting at the Hotel Pennsylvania on December 1. Harold V. Coes, retiring president of the society, and Ralph S. Damon, general manager of American Airlines, Inc., were the speakers.

The medal of the society was awarded to Lewis K. Sillico, a fellow of the society, first vice-president of the New York Airbrake Company and vice-president of Hydraulic Controls, Inc., Chicago. Established in 1920, the medal is given for "distinguished service in engineering and science." The citation accompanying the award reads in part: "Eminent engineer executive, distinguished lecturer . . . a lover of wisdom . . . for his preeminent and permanent contribution to the art and science of engineering, of transportation, of education and the fine art of living."

Dr. Vannevar Bush, president of the Carnegie Institution of Washington; D. C., and director of the Office of Scientific Research and Development, was awarded the Holley Medal as "engineering educator, inventor and leader in scientific research," for "machines used in easing applied mathematics from computational barriers." This medal, instituted and endowed in 1924 by George I. Rockwood, past president of the society, is given for engineering genius that has accomplished "a great and timely public benefit." Dr. Bush is the builder of the differential analyzer, a machine for solving differential equations.

Igor I. Sikorsky, of Vought-Sikorsky Aircraft, Stratford, Conn., a fellow of the society, inventor of the helicopter and the Sikorsky multi-motored amphibian, received the Worcester Reed Warner Medal, given for a paper dealing with progressive ideas in mechanical engineering or efficiency in management. The medal was awarded "for his stimulation of the engineer in those priceless attributes, imagination and creative ability" and for his inspiration to young engineers engaged in research and development.

Three awards were made which are presented jointly with other societies:

Dr. Charles F. Kettering, of Detroit, general manager of the Research Laboratories Division of General Motors, president of C. F. Kettering, Inc., and vice-president of General Motors, was presented with the John Fritz Medal for 1944. The citation reads: "For notable achievements in the field of industrial research which have contributed greatly to the welfare of mankind and of the nations." In addition to the John Fritz Medal, the American Society of Mechanical Engineers Medal for 1940, which had never been formally conferred, was given to him for "outstanding invention and research."

The Alfred Noble Prize, a cash award given jointly by the American Society of Mechanical Engineers and four other engineering societies, was presented to Dr. Benjamin J. Lazan, of Greenwich, Conn., chief engineer of the Sonntag Scientific Corporation, for his monograph: "Some Mechanical Properties of Plastics and Metals under Sustained Vibration."

Dexter Simpson Kimball, dean emeritus of the College of Engineering of Cornell University, was awarded the Henry Laurence Gantt Memorial Gold Medal for "outstanding attainment in the teaching and practice of industrial management and for distinguished contributions to its literature." He is a fellow, honorary member and past president of the American Society of Mechanical Engineers and a Warner Medalist. This award is presented jointly with the American Management Association.

## SCIENTIFIC NOTES AND NEWS

DR. H. H. BENNETT, chief of the Soil Conservation Service, and Dr. Robert V. Allison, of the Florida Experiment Station, will receive from the President of Cuba at the 1944 meeting of the Cuban National Congress of Soil and Fertilizers the Carlos Manuel de Cestenes decoration in recognition of soil studies and investigations made in Cuba from 1924 to 1926.

THE council of the Royal Meteorological Society, London, has awarded the Symons Gold Medal for 1944 to Dr. C. W. B. Normand, director-general of observatories in India. The medal is awarded biennially for distinguished work in connection with meteorological science.

PROFESSOR BASIL F. J. SCHONLAND, F.R.S., director of the Bernard Price Institute of Geophysics and Carnegie-Price professor of geophysics in the University of Witwatersrand, Johannesburg, has been awarded the South African Medal and Grant for 1943 by the council of the South African Association for the Advancement of Science. At present, Professor Schonland is on service as a brigadier in the Union Defence Force, seconded for specialized scientific work with the military authorities in England.

DR. LLOYD M. PIDGEON, of the National Research Council of Canada, has been awarded the platinum medal of the International Nickel Company by the Canadian Institute of Mining and Metallurgy and the special merit medal of the Professional Institute of the Civil Service of Canada for his development of a process for the production of magnesium. Dr. Pidgeon was recently appointed head of the department of metallurgical engineering of the University of Toronto.

DR. CECIL J. WATSON, head of the department of medicine of the University of Minnesota, has been elected president of the Central Society for Clinical Research.

At the meeting of the Eastern Pennsylvania Chapter of the Society of American Bacteriologists on November 23 the following officers were elected for the year 1944: *President*, Dr. Earl W. Spaulding, department of bacteriology of the School of Medicine of Temple University; *Secretary-Treasurer and Councilor*, Dr. Harry E. Morton, department of bacteriology of the School of Medicine of the University of Pennsylvania; *Councilor's Alternate*, Dr. Ruth E. Miller, of the department of bacteriology of the Woman's Medical College of Pennsylvania.

HAROLD N. BIXLER, personnel director of the Mutual Life Insurance Company of New York, has been elected chairman of the American Society of Safety Engineers.

DR. R. K. STRATFORD, chief chemist of the Imperial Oil Company, has been elected president of the Canadian Institute of Chemistry.

OFFICERS of the Royal Society of Edinburgh have been elected as follows: *President*, Professor E. T. Whittaker; *Vice-Presidents*, Dr. James Watt, Professor T. H. Milroy, Sir John Boyd Orr, Dr. A. W. Greenwood, Professor E. Hindle and Dr. D. Russell; *General Secretary*, Professor James P. Kendall.

LIEUTENANT-COLONEL W. B. R. KING, Yates-Goldsmid professor of geology at University College, London, from 1912 to 1920 a member of the Geological Survey of Great Britain, has been appointed Woodwardian professor of geology at the University of Cambridge.

PROFESSOR H. GORDON JACKSON, who has been head of the department of zoology of Birkbeck College, London, since 1921 and professor since 1928, has been appointed head of the college.

DR. CLIFFORD B. PURVIS has succeeded Professor Harold Hibbert as Eddy professor of industrial and cellulose chemistry at McGill University. Professor Hibbert had reached the retiring age.

G. H. RAWCLIFFE has been appointed to the chair of electrical engineering in the University of Bristol in succession to the late Professor D. Robertson.

DR. GEORGE B. DARLING, president and comptroller of the W. K. Kellogg Foundation, has resigned to become associated with the division of medical science of the National Research Council.

DR. DONALD H. JACOBS, associate physicist at the National Bureau of Standards, has been appointed senior physicist at the U. S. Naval Observatory, Washington, D. C.

H. ARTHUR MEYER, assistant professor of forestry at Pennsylvania State College, has leave of absence to enable him to accept an assignment for cinchona procurement for the Office of Economic Warfare.

RECENT appointments to the staff of the biological division of Food Research Laboratories, Inc., Long Island City, New York, include Dr. Nathan Rakieta, formerly of the Laboratory of Applied Physiology of Yale University and lately first lieutenant, U. S. Army Air Corps, and Dr. Roslyn T. Roth, formerly research microanalyst at New York University and more recently biochemist at the New York Psychiatric Institute, Columbia Medical Center. Dr. Rakieta will supervise the animal laboratories; Dr. Roth will specialize in the statistical aspects of the design and interpretation of bioassays.

SIR GEORGE THOMPSON, professor of physics at the Imperial College of Science and Technology, London, has been appointed scientific adviser to the British Air Ministry.

*Nature* writes that "scientific men and many others will learn with much pleasure that Professor Niels Bohr, of the Institute of Theoretical Physics, Copenhagen, has succeeded in escaping from Denmark and has reached Great Britain."

DR. WILLIAM McDOWELL HAMMON, assistant professor of epidemiology at the Medical School in San Francisco of the University of California, and Dr. H. G. Johnstone, assistant professor of bacteriology, are studying tropical medicine in Central America through the cooperation of the Office of Inter-American Affairs and of the Surgeon-General of the Army.

*Nature* reports that Professor A. V. Hill, secretary of the Royal Society, will visit India to advise on problems of scientific and industrial research in relation to reconstruction problems and the coordination of such research in India with that elsewhere. His tour is being undertaken at the invitation of the Government of India and with the consent of the Royal Society.

DR. J. HOWARD MUELLER, professor of bacteriology and immunology at the Harvard Medical School, will deliver on December 16 the third Harvey Society lecture of the current series at the New York Academy of Medicine. He will speak on "Nutrition of the Single Cell; its Applications in Medical Bacteriology."

DR. FRANK B. JEWETT, vice-president of the American Telephone and Telegraph Company, president of the National Academy of Sciences, spoke on December 1 on new scientific and technological developments and their application to postwar economy at an open-forum meeting of the Institute on Postwar Reconstruction of New York University.

DR. GEORGE L. CLARK, professor of chemistry of the University of Illinois, on November 19 addressed the University of Cincinnati Chapter of Sigma Xi on "The Role of the Electron Microscope in Physical, Chemical, Industrial and Biological Research."

DR. F. C. BARTLETT, professor of experimental psychology in the University of Cambridge, gave on November 23 the Huxley lecture of the Royal Anthropological Institute, London. He spoke on "Anthropology in Reconstruction."

THE November and December program of lectures arranged by the Royal Institution, London, include a lecture by Sir Joseph Barcroft, F.R.S., on the preservation of foods by drying, and by Professor H. W. Florey, F.R.S., on the development of penicillin for

medical uses; a course of lectures will be given on the progress in the treatment of infections by Sir Henry Dale, P.R.S., and a course by Professor J. C. Drummond on the food problems of the post-war years.

THE annual meeting of the Society of Automotive Engineers will be held at Detroit from January 10 to 14.

IN response to a request made by the second Conference on X-ray Analysis held in Cambridge last April, the Board of the British Institute of Physics has authorized the formation of an additional group empowered to arrange meetings and conferences and generally to be a medium for the exchange of information on matters relating to x-ray diffraction. The organizing committee of the conference, which was requested to act as the first group committee, has elected Professor Sir Lawrence Bragg as chairman and Dr. H. Lipson as honorary secretary and treasurer.

THE Associated Defense Committees of Chicago Technical Societies have issued an urgent request for the names and addresses of all engineers or scientists who have technical information concerning industries, communications, transportation, raw materials, etc., of any areas in Europe or in the Pacific which are now held by the enemy or might conceivably become theaters of war operations. The committee is also looking for still pictures or moving pictures showing coastlines, harbors, industrial centers, and the like, of such areas. Those having such information or knowing of some one who has such information should communicate at once with Robert C. Brown, Jr., chairman of the Associated Defense Committees, 226 West Jackson Boulevard, Chicago, giving as much detail as possible concerning the type of information that is available.

*Chemical and Engineering News* reports that the National Department of Health Service of Mexico City has sent fifteen representatives to study for two terms in the School of Public Health at the University of Michigan. Included in the group are four public health nurses, five public health engineers and six veterinarians. Expenses are paid by the W. K. Kellogg Foundation.

THE faculty and administrative officers of the Philadelphia College of Pharmacy and Science have gone on record as being definitely opposed to further acceleration of courses beyond the current war-time plan of conducting the usual four-year course in two years and nine months. Following is a resolution unanimously passed at a meeting of the faculty:

WHEREAS: Any lowering of the standards of pharmaceutical education means the inevitable defeat of the effort

keep pharmacy in the status of a profession, therefore it

*Resolved:* By the Faculty of the Philadelphia College of Pharmacy and Science, that we deprecate any movement to shorten the time devoted to the course of pharmaceutical education in the college, and be it further

*Resolved:* That we request the Board of Trustees of the college to return, as soon as practicable, to the previous requirement of four calendar years of study as a requisite for the degree of bachelor of science in pharmacy, and be it further

*Resolved:* That a copy of these resolutions be properly publicized to the end that it may be realized that the Philadelphia College stands to-day, as it has in the past, on sound educational principles.

THE board of trustees and the dean of the Texas Dental College at Houston announced recently that the program of dental education conducted by the college would be discontinued on August 31 and that the properties of the college would be given to the University of Texas. The school of dentistry was opened on September 1 in the properties acquired by gift from the Texas Dental College, which was founded in Houston in February, 1905. It was organized as a public trust in 1929. Dr. F. C. Elliott has been dean of the college since 1932 and has been named dean of the School of Dentistry of the University of Texas. The Chamber of Commerce of Houston gave a testimonial dinner for Dr. Elliott on June 3 at which he was highly praised for his part in the transfer of the college to the university and for his many public services to the city of Houston and to the State of Texas in the promotion of public health.

AFTER establishing life trust funds of \$200,000, the will of the late former Governor Horace White provides that three fourths of the residuary estate shall go to Cornell University at Ithaca and one fourth to Syracuse University. Income from the fund at Cornell University will be applied in whole or in part "to pay or increase salaries of officers and members of the faculty who have rendered distinguished services or who may be of great value to the university." Syracuse University's share in the estate will be known as "the Horace White Fund" and the income will be used

to pay the salary of "the Edward C. Reifenstein professorship of medicine." The \$200,000 set up for life trusts ultimately will revert to the two universities in their proportionate shares.

It is announced by the Mining Association of Great Britain that the colliery owners of Great Britain will provide further sums, of the order of half a million pounds, for coal research, in order to extend their existing program, which itself involves the expenditure of £1,000,000 over the current five years. The new program relates to the development of processes for producing hydro-carbons and hydro-carbon derivatives from coal and to the treatment of coal generally as a chemical raw material. The program will begin immediately, and the colliery owners will themselves contribute between £400,000 and £500,000 towards its cost during the period ending with 1945.

ACCORDING to *Nature*, a million dollars has been set aside by the British Council for the Promotion of Science and Technology in China as cash awards for solutions of national defense scientific problems. The Council for the Promotion of Science and Technology has selected ten special industrial and scientific problems for consideration. Chinese men of science, industrial technicians and research workers are invited to engage in studies and research on these problems and submit reports of their results to the council before the end of the current year.

THE South African Standards Institution, which is the national standardizing body in the Union and incorporates the South African branch of the British Standards Institution, recently reelected Professor John Orr as chairman. He has led the standardization movement in South Africa since its inception more than thirty years ago.

It is reported in the daily press that the University of Lublin, Poland, has been formally adopted for the duration of the war by Fordham University. The Reverend Robert I. Gannon, S.J., president of the university, pointed out that the adoption was "a slight return for the cultural help and influence which our universities have received from the Old World."

## DISCUSSION

### TRYPTOPHAN AND PHYTOHORMONE PRECURSORS

It has been shown by different workers<sup>1,2,3</sup> that certain plant tissues, upon alkaline hydrolysis, give much larger yields of auxin than unhydrolyzed tissues.

<sup>1</sup> G. S. Avery, Jr., J. Berger and B. Shalucha, *Amer. Jour. Bot.*, 28: 596-607, 1941.

<sup>2</sup> A. J. Haagen Smit, W. D. Leech and W. R. Bergren, *Amer. Jour. Bot.*, 29: 500-506, 1942.

<sup>3</sup> E. S. J. Hatcher, *Nature*, 151: 278-279, 1943.

This and related work has established the existence of one or more naturally occurring compounds which have been called auxin "precursors"; they become auxin only after suitable treatment. The chemical identity of such precursors has not been established, but a suggestive paper has been published recently.<sup>4</sup> It reports that the amino acid tryptophan, upon alkaline hydrolysis, yields an auxin which is presumably

<sup>4</sup> S. A. Gordon and S. G. Wildman, *Jour. Biol. Chem.*, 147: 389-398, 1943.

indoleacetic acid; and that tryptophan-containing proteins (casein and several purified protein preparations from spinach leaves) similarly yield auxin upon treatment with alkali. From these results the authors<sup>4</sup> conclude that "it is not improbable that tryptophane does occur as such in plants, and until it can be definitely shown that there is no conversion of this substance to auxin under the influence of alkali treatment, reported increases in auxin liberation must be viewed with misgiving." This implies that yields obtained by alkaline hydrolysis are in the nature of artifacts. But, rather than causing "misgiving" over the alkaline hydrolysis method, it seems to us that the paper in question supports its value as an extraction method, i.e., it may be such substances as tryptophan in plant tissues which are the precursors. Indeed, it has been reported that tryptophan is convertible to auxin by plant tissues<sup>5,6</sup> and by ultra-violet light.<sup>7</sup>

It has been shown<sup>1,2,3</sup> that approximately 90 per cent. or more of the total auxin obtainable from kernels of corn, wheat and rye is present in the kernels not as auxin, but as a precursor. Thus there is an enormous conversion of a physiologically inactive compound into auxin. Before attaching too much importance to the possibility of tryptophan being the precursor in corn and wheat, it is to the point to compare the magnitude of the conversion obtained from pure tryptophan and that from plant tissue. The maximum yield of auxin (calculated as indoleacetic acid) from alkali treatment of tryptophan is 0.008 per cent., and from a tryptophan-rich protein, casein, is 0.001 per cent. (Gordon and Wildman, tables 3 and 4).<sup>4</sup> In contrast, the maximum yield of auxin from alkali treatment of fresh whole grains of sugar corn is 0.084 per cent. (84 million TDC per gram), calculated on dry weight of the corn.<sup>8</sup> This is at least ten times as high as the conversion from pure tryptophan. If our figures are correct, they indicate that the precursor in corn is not tryptophan.

Evidence in favor of the non-artifact nature of the auxin produced by alkaline hydrolysis of corn is provided by the experiments of van Overbeek.<sup>9</sup> Using a technique which involved exhaustive diffusion, van Overbeek reports that about 90 per cent. of the total auxin obtainable from the coleoptile tips of corn seedlings occurs not as auxin, but as a precursor.

Wheat, upon alkaline hydrolysis, has been reported<sup>1,2</sup> to give increases in auxin yield up to 3 to 6 mg indoleacetic acid per kg of kernels (over that of unhydrolyzed tissue). Contrary to the calculation

of Gordon and Wildman, which seems to be in error by a factor of one million,<sup>10</sup> such increases are very much in excess of any activity obtainable from the tryptophan in wheat.

It has been pointed out in the work of this laboratory that the alkaline hydrolysis method is unsatisfactory for a number of green tissues.<sup>8</sup> These tissues presumably contain tryptophan, but it is obvious that the conversion of tryptophan to auxin was too little to be detected.

From diffusion curves, Gordon and Wildman (see their Fig. 1) conclude that the auxin produced is probably indoleacetic acid.<sup>11</sup> It should be noted that indoleacetic acid is stable to strong alkali: whereas no auxin is obtained from tryptophan with 0.25 N sodium hydroxide at 100° C. for 15 minutes, identical treatment of corn gives maximum auxin yields. Thus, it is unlikely that indoleacetic acid is the auxin produced from tryptophan by alkaline hydrolysis.

In Table IV<sup>4</sup> the data show that mild acid treatment of tryptophan (phosphate buffer at pH 4.6) gives higher yields of auxin than any other treatment described in the paper. Opposed to this is another datum in the same table, that a tryptophan solution adjusted to pH 4.6 gives no auxin. These results are difficult to understand. If the former is correct, it is still further evidence that the auxin precursors in corn and wheat are not tryptophan, since they do not give auxin under such conditions.

The tentative conclusion that tryptophan is not identical with the corn and wheat auxin precursors rests chiefly on the fact that the per cent. conversion of natural precursors to auxin is very much higher than that of pure tryptophan to auxin. Since it might be argued that tryptophan would show a higher percentage conversion into auxin in the presence of plant materials, we have hydrolyzed mixtures of tryptophan and ground corn kernels, and tryptophan and purified corn auxin precursor in varying amounts by weight, at pH 9.7 for 30 minutes. Avena assays indicate no appreciable increase in auxin yield from the tryptophan in either case. For example, 250 mg ground dry sugar corn alkali-hydrolyzed in the presence of 100 mg of *l*-tryptophan (Merck) gave 17.6° curvature at 1:16,000, compared with 13.8° curvature for corn hydrolyzed alone. The curvature attribut-

<sup>10</sup> Correspondence from Dr. Gordon recognizes that his 0.6 mg should be 500 grams (G. and W., p. 397). The agar block size referred to on page 389 of their work, Dr. Gordon informs us, should be 9 cm, and the subsequently calculated figure should be  $1.8 \times 10^{-4}$   $\mu$ g.

<sup>11</sup> A number of other possible intermediates of tryptophan breakdown were eliminated because of their physiological inactivity, although indolepyruvic acid, a very likely intermediate with 1.0 per cent. of the activity of indoleacetic acid, seems not to have been considered (suggested by Skoog<sup>5</sup>). 2-Indoleacetic acid is also a possible product.

<sup>5</sup> F. Skoog, *Jour. Gen. Physiol.*, 20: 311-334, 1937.

<sup>6</sup> W. S. Stewart, *Bot. Gaz.*, 102: 801-805, 1941.

<sup>7</sup> A. Berthelot and G. Amoureux, *Compt. Rend.*, 206: 699, 1938.

<sup>8</sup> G. S. Avery, Jr., J. Berger and B. Shalucha, *Amer. Jour. Bot.*, 29: 765-772, 1942.

<sup>9</sup> J. van Overbeek, *Amer. Jour. Bot.*, 28: 1-10, 1941.

able to tryptophan conversion is equivalent to a 0.015 per cent. yield of indoleacetic acid from pure tryptophan, versus a 0.022 per cent. yield of indoleacetic acid from crude corn. If tryptophan were the corn auxin precursor, then corn would have to be pure tryptophan, which is obviously absurd. It may be safely concluded, therefore, that tryptophan is not the corn auxin precursor to which most of the auxin activity is attributable.

On the other hand, it may be concluded from the work of other investigators<sup>5,6</sup> as well as from that of Gordon and Wildman, that tryptophan is a plant auxin precursor of a low degree of activity. Their results<sup>4</sup> suggest that auxin yields obtained from green tissues by methods involving extraction periods of many weeks<sup>12</sup> may possibly be attributable to tryptophan conversion into auxin.

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### THE ROOTS OF SPINAL NERVES

EVERY one acquainted with the structure and function of the spinal nerves is aware of their threefold origin. Although this fact was recognized and generally accepted during the closing years of the nineteenth century, present-day descriptions of the spinal nerves continue to be based on the knowledge of a still earlier day. Consequently, they are initially misleading and always cause the beginner unnecessary difficulty in gaining an appreciation of the sources and functions of the fibers in peripheral nerves.

Each spinal nerve contains axons arising from cell bodies located in dorsal root ganglia, in the spinal gray matter and in the ganglia of the sympathetic chain. Fiber bundles from the first two mentioned sources are known as roots of the nerve, but the bundle from the third source is reduced to the status of a branch or ramus in all current descriptions. There seems to be no reason for continuing this erroneous designation except long-established custom. While it is true that the gray root is much smaller and joins the rest of the nerve at a point some distance removed from the union of the dorsal and ventral roots, such differences are mere details of pattern in comparison to the complete reversal of meaning occasioned by referring to a root as a branch; or, in the sense that these terms are employed, in speaking of a contribution as a derivative.

To obviate the above-mentioned misnomer in present terminology the following changes in the description of spinal nerves are proposed: (1) With an occasional exception, all spinal nerves are formed from three roots, a dorsal, a ventral and a gray (sympathetic).

<sup>12</sup> K. V. Thimann, F. Skoog and A. C. Byer, *Amer. Jour. Bot.*, 29: 598-606, 1942.

(2) Every spinal nerve gives rise to three primary rami and some of them give rise to four; the constant rami are the dorsal, the ventral and the recurrent, while the one arising from only certain of the nerves is the white (visceral) ramus. A white ramus springs from each of the thoracic nerves, the cranial three lumbar and the third and fourth sacral nerves; in addition, a white ramus may issue from the eighth cervical, the fourth lumbar or the second sacral. (3) The trunk of the spinal nerve is the portion between the roots; i.e., it extends from the junction of dorsal and ventral roots to the point where the gray root joins the bundle formed by the union of the other two. By this definition the dorsal, the recurrent and the anterior rami arise directly from the trunk; but the white ramus is peculiar in that it may arise from the trunk, from the anterior ramus, or pass to the sympathetic chain enclosed in a sheath common to it and the gray root.<sup>1</sup> As to the composition of the rami with respect to the triple origin of the parent trunk, the dorsal and ventral rami contain fibers from all three roots, the recurrent carries fibers from the dorsal and the gray roots, and the white ramus receives fibers from the dorsal root and from the ventral root. It is to be noted that the white ramus alone carries dorsal and ventral root fibers only as implied for all rami in the usual introductory description.

That all spinal nerves have not two roots, but three, is factually correct. The question raised is: Shall all three roots be known as such or shall one of them remain disguised as a ramus and so continue to confuse and confound those who must eventually learn that the nerves to skin contain not only afferent fibers but efferent fibers as well; that in nerves to muscle, fibers from all three sources are generously represented; and that the white rami instead of being strictly efferent contain abundant afferent fibers? The author is aware that some afferent fibers may course with the gray ramus, that dorsal roots apparently carry efferent impulses as well as afferent, and that the possibility of afferent fibers in the ventral roots may not be excluded entirely. However, the errors imposed in neglecting to mention these facts in an introduction to the subject seem trivial compared to the continued persistence of the term "gray ramus" when the structure so named has long been established as a root—and an important one—of each and every spinal nerve.

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### TAXONOMY AND GENONOMY

SYSTEMATIC biology has been occupied in the past primarily with the end results of speciation. The object of practising systematists has been to define

<sup>1</sup> D. Sheehan and J. Pick, *Jour. Anat.*, 77: 125, 1943.

the limits of the entities which they have discovered and to arrange them according to their resemblances. The methods employed have been principally those of comparative morphology. The relationships within these entities and the intraspecific structure which is conditioned by the ecology of reproduction have been neglected or but little attended to. Either they have been overshadowed by the practical necessity of creating a workable system, or their study has lagged because of the inadequacy or absence of the necessary techniques. In recent years, however, some systematists, augmenting the orthodox methods by others more suitable, have undertaken to analyze these phenomena. They have become interested not so much in the broader relationships which exist between species and between genera, relationships which can be inferred only from observation and on which no experimental attack is possible, but in the more intimate familial relationships of the individuals which comprise a species. By these studies it is hoped that they may peer beyond the end results of speciation and learn more directly its causes and course. They also believe that thereby a more satisfactory arrangement can be devised.

Several terms have been applied to such studies; they have been variously described as the "new" systematics, as biosystematics and as population genetics. These terms are awkward and are not wholly revealing. None has gained more than tentative acceptance despite the need for a term which can be generally applied. I am venturing therefore to propose the term *genonomy* to connote these laws of the blood relationship, coined from the Greek words  $\tau\omicron$   $\gamma\acute{\epsilon}\nu\omicron\varsigma$  (the race or offspring) and  $\delta$   $\nu\acute{o}\mu\omicron\varsigma$  (the law or ordinance). This term can be used in apposition to the term *taxonomy*, which can be defined as the laws of arrangement and employed to connote what Turrill has termed "alpha" taxonomy. If the need is felt for a more inclusive term to embrace both fields of ac-

tivity, I suggest that the term *systematics* be used in this broader sense. As employed at present it is somewhat ambiguous, but more or less synonymous with taxonomy. To illustrate concretely by a study in progress: "The Systematics of *Delphinium Hanseni*" would subsume both its taxonomy and its genonomy. The former would embrace the usual studies of arrangement: nomenclature, differentiation and description of the entities and their geographic distribution. The latter would embrace studies entailed by the familial relationships of individuals, such as their breeding structure, intraspecific variation and its distribution, ploidy, the investigation of certain natural hybrids and the relationship of the entities involved in the polyploids and hybrids.

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#### ISOLATION OF INFLUENZA A BY INTRA-ALLANTOIC INOCULATION OF UNTREATED THROAT WASHINGS

WE wish to report that in this laboratory it has been possible to isolate and identify influenza virus A from untreated, unfiltered throat washings by intrallantoic inoculation of developing chick embryo. The Hirst red cell agglutination-inhibition test was used for identification.

During a current epidemic twenty untreated unfiltered throat washings freshly collected in 20 per cent. normal horse serum saline have yielded four positive agglutinations on the first passage. One of these was verified as Influenza A by the agglutination-inhibition test.

Details of further studies will be published later.

MINNIE THIGPEN  
JAMES CROWLEY

INFLUENZA LABORATORY,  
DIVISION OF PREVENTABLE DISEASES,  
MINNESOTA DEPARTMENT OF HEALTH

## SCIENTIFIC BOOKS

### NATURALIST AT LARGE

*Naturalist at Large*. By THOMAS BARBOUR. 314 pp. Little, Brown and Company, Boston. 1943.

WE use the expression "emergent evolution" to designate apparent mutations, which are really due, not to any change in the germ-plasm, but to a new combination of genes, giving a result which may be as wonderful as it is unforeseen. We must suppose that the elements which, coming together in the right manner and proportion, gave us Thomas Barbour, existed in his ancestors, even in those remote ancestors who would now be called savages. We are filled with

a sense of wonder and mystery when we think of these early origins, destined to find their highest significance in a future then remote. If we ask what these elements were, we find the answer in Barbour's book. An intense curiosity about the phenomena and significance of animal life, a desire to discover facts hitherto unknown, a very keen sense of the beauty of nature, a remarkable capacity for friendship—all these faculties, separately or in combination, must have served Barbour's ancestors well, but it was a happy chance that brought them together in a single outstanding individual. But even so, nurture had to be added to

nature, or the results might have been insignificant. Says Barbour: "I knew Professor Henry Fairfield Osborn, the president of the Zoological Society, because one of his sons was a schoolmate of mine. To me, a shy fifteen-year-old in those days, he seemed very awesome, but one Saturday afternoon he did something which enriched my life more than he ever realized. On this occasion he sat down beside me in the train going back from the Bronx to Grand Central Station. He asked me what I had been reading and then said: 'There are four great books for boys who like natural history.' And he named them: Wallace's 'Malay Archipelago,' Belt's 'The Naturalist in Nicaragua,' Bates's book on the Amazon, and Hudson's on the La Plata region. Well, I read them in this order. Wallace's book, coming first, made the greatest impression; I read it over and over again until I knew it almost by heart. And my desire to see the Dutch East Indies became so all-consuming that I must have seemed a veritable monomaniac to my parents."

Barbour thus stepped into Wallace's shoes, for in many respects the two men were very much alike. I think especially of their delight in the beauty and variety of nature, for although they wrote no poems, they had to the full the feeling which inspires the best poetry.

The book is divided into three parts—(1) The Making of a Naturalist; (2) The Sedentary Naturalist; (3) The Leisurely Naturalist—with also a couple of appendices. Each chapter deals with some special topic, the result being more interesting than a strictly chronological narrative. There is a very good chapter on Mr. Justice Holmes, of whom it is said:

I still believe that had Justice Holmes known as much about science as he knew about philosophy, ethics, logistics or history, he would have been forced to admit that there are certain categories of facts for which science holds no key. And this is where the deist, the humble soul who makes no parade of his religious belief, feels positive that he has something quite tangible, which the atheist has not. Justice Holmes was completely happy and satisfied but, in regard to science, he was extraordinarily trusting and uninformed. With all his learning, with all his vast and mature scholarship which gave him that superb beauty of utterance, of imagery, and of apt quotation which decorated the ornate loveliness of his literary style, Mr. Holmes still had his blind spot.

But Barbour concludes: "Justice Holmes was one of the greatest men I ever knew well—if not the very greatest."

Barbour's life work has been in and for the Museum of Comparative Zoology at Harvard, where he has been the successor of Louis and Alexander Agassiz. He describes the growth of the museum and the work

of his associates, and tells some strange tales of earlier days. "You see, my thesis is that working in a museum used to make people odd. Of course, that's not the case of my colleagues or me. As one of my daughters said of us, 'You don't have to be crazy, but it certainly helps.'"

There is much to be said about the Barro Colorado Island Laboratory in the Panama Canal. Barbour says that if ten friends of his were asked to speculate on the best job he had ever done, nine would agree that it was the help given to the Barro Colorado Laboratory. However this may be, the service rendered was very great, and although, under the stress of war, the laboratory is now closed, the work will continue in days of peace, presumably for centuries to come, and will be a source of inspiration to many generations of naturalists.

Probably few spots in the world have provided more intellectual thrills or satisfied more intellectual curiosity than has Barro Colorado Island. Every naturalist, be he high-school teacher or independent investigator or college professor of biology, craves a chance to see a tropical rain forest, if only for once in his life, and many who have had their first chance on Barro Colorado Island have returned there again and again. . . .

I don't know whether I shall ever see Barro Colorado again, but I certainly hope that I may, if only to sail by it through the Canal in the month of March, when the guayacan trees lift their lofty heads above the forest top, each as glittering as a golden dome, while the purple Jacarandas, the pale pink alemendros and the Palo Santo with flowers as crimson as arterial blood make a scene of incomparable splendor [pp. 206, 207].

The chapter "In Retrospect" is an attempt at self-analysis, as objective as he can make it. He says: "This year, in the midst of a war-torn world, I have been thinking hard about the whole question which every elderly person in an administrative capacity has been pondering—as to whether or not he is pulling his weight in the boat at times like this. Or should I shut the museum up and walk away from it for the duration? . . . Well, the stars have shone for me in the form of some lines recently written by my friend, Dr. Albert Eide Parr, the distinguished new director of the American Museum of Natural History in New York." Parr's statement concludes with these words:

The effort of our physical victory may also prove wasted if in the meantime we have lost on the spiritual front. And I do not propose to apologize for having sufficient faith in our ultimate victory to consider the continued growth and development of the cultural and educational institutions to be one of the most essential duties which can be borne in our nation to-day, second only to the duty of those defending our right to have the civilization we want. At least that is the conviction in which I myself carry on.

It is natural that different individuals, according to their training and circumstances, should feel differently about these matters, so also the same individual at different times. But one feels that some of the things done, such as the evacuation of the three great museums at San Diego, which would have contributed greatly to the education of the men in service, has resulted from a feeling of indifference to cultural values on the part of those in authority. Let us hope that in the days to come the better life which we now see through dark glasses may not only restore our civilization but make it far more interesting and serviceable to the average man.

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### DEVELOPMENTS IN SCIENCE

*Forward with Science.* By ROGERS D. RUSK. Alfred A. Knopf Company. 307 pp. \$3.50.

THIS book by Rogers D. Rusk, is intended as a guide to non-scientists, to keep them in touch with the present developments in science and to review for them some of the philosophical implications, as well as to describe the practical consequences of the thought of the past two decades. It is not intended to be a text and therefore fits into the category of the other books explaining science to the layman, such as the familiar ones by Jeans and Eddington.

Dr. Rusk sets forth for the average layman the points of view which have been developed by science in recent times and outlines some of the interesting results. He starts out by explaining the triumphs of modern physical science and discusses the structure of matter and the newly discovered fundamental particles. He then shows us immediately how these particles are used. He devotes one chapter to the electron microscope, another to x-rays, and still others to artificial radio-activity and atomic energy. Then Rusk describes cosmic rays and reviews the evidence for the age of the earth. The remainder of the book is devoted to a more philosophical view of the problems posed by modern science. The author explains the difficulties of the mechanistic view and the importance of the development of the wave and probability concepts which form the basic operational philosophy of modern physics. His later chapter headings are suggestive, as "Reaching for the Stars," "Does Nature

Make Sense?", "Man Outgrows Mechanism" and "Human Freedom and Destiny."

Finally, toward the end of the book Rusk also considers science and destruction. He attempts to set at ease the minds of those who worry about the destructive forces unleashed by science by reminding them that science provides power and tools for the use of mankind and that it is not the fault of science that some of these tools have been used by misguided persons for destructive purposes.

Dr. Rusk, being himself a physicist, is, of course, thoroughly conversant with his subject and cites extensively the original fundamental and significant experiments. He has clearly explained the rather complex ideas which have been formulated and developed by the leaders of present-day physical thought, such as Heisenberg, de Broglie, Schrodinger and Bohr. Since physics has grown during the past ten years to vast dimensions it is impossible to do justice to all phases of it in a book of this length. One is therefore left with the feeling at the end of many chapters that more should have been added about the subject and that the arguments and treatments are incomplete. Also, in reading the book a physicist would feel that in Dr. Rusk's development of the subject he departs from the classical order of presenting the material. This departure from the traditional presentation tends to give the impression that the author jumps around too much for so broad a field and does not always finish the ideas which he has started to explain. On the other hand, many of the facts in the book are excellent and certainly reflect the current thought in physics. Many of us have felt, as does Dr. Rusk, that the philosophical point of view developed by Jeans and Eddington had gone beyond the true province of science, particularly in Jeans' discussion of determinism and in his famous conclusion that since physics is mathematical, therefore God must be a mathematician. It is most encouraging therefore to hear a fellow physicist point out the difficulties with this point of view and to hear him explain the feelings which have been commonly shared by many of us in this field.

On the whole, Rusk has done a good job, and has presented the subject to the layman in a most interesting and readable book.

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## SPECIAL ARTICLES

### RETARDATION OF RANCIDITY BY SULFHYDRYL COMPOUNDS

BIOLOGICAL antioxidants, as food constituents, are attracting increasing attention. Apart from the to-

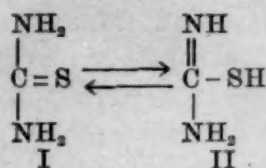
copherols, which Mattill and his associates first demonstrated as having antioxygenic potency,<sup>1,2</sup> crude

<sup>1</sup> H. S. Olecott and H. A. Mattill, *Chemical Reviews*, 29: 257, 1941.

sources of the vitamin B complex have also, recently, been recognized as potent antioxidants.<sup>3, 4, 5</sup>

In the course of investigations dealing with the retardation of rancidity in dried milks,<sup>5</sup> thiourea was examined as a possible antioxidant for fat. It has been claimed that thiourea is a good stabilizer for ascorbic acid<sup>6</sup> but its possible antioxygenic effect on fats required special study. From such experiments<sup>5</sup> it became evident that thiourea is capable of acting as a fat antioxidant, but only in the presence of water.

It is plausible to assume that the antioxygenic properties of thiourea (I) can be attributed to the sulfhydryl residue in its tautomeric form, isothiurea (II).



This idea carries with it several practical implications which are open to experimental verification.

1. Iso-thioureas having a substituent attached to the sulfur atom should not exhibit antioxygenic properties. On the other hand, N-substituted thioureas having a hydrogen atom available for enolization should act as antioxidants.

2. Other sulfhydryl compounds, for instance, cysteine (but not cystine), should also be good antioxidants, at least *in vitro*.

3. Cu<sup>++</sup> and Fe<sup>+++</sup> ions should inhibit the antioxygenic potency of sulfhydryl compounds.

Experiments were set up to test the above postulates. For the assay method a modified dried system<sup>7</sup> was used, composed of cornstarch (18 gram), redistilled linoleic acid (3.5 gram) and antioxidant (43 mg), with or without the addition of water (1 gram of water replacing 1 gram of starch) and of CuSO<sub>4</sub> (10 mg in the total mixture). The ingredients were thoroughly mixed and incubated at 30°. On the eighth day the fat was extracted with CHCl<sub>3</sub> and the iodine number determined.

The experimental results contained in Table I indicate the correctness of the assumption, according to which, sulfhydryl-compounds by virtue of their free sulfhydryl radical retard the development of rancidity

TABLE I  
EFFECT OF WATER AND OF CuSO<sub>4</sub> ON THE ANTIOXYGENIC POTENCY OF SULFHYDRYL COMPOUNDS AND OF HYDROQUINONE-MONOBENZYLETHER

Antioxidant (0.2 per cent.)	H <sub>2</sub> O per cent.	CuSO <sub>4</sub> mg.	Iodine No.	
			Exper. 1	Exper. 2
Cysteine	0	0	43.5	
Cysteine	4.65	0	113.8	114.1
Cysteine	4.65	10	46.6	42.4
Cystine	0	0	54.5	
Cystine	4.65	0	55.9	
N-Acetylthiourea	0	0	55.4	
N-Acetylthiourea	4.65	0	122.0	128.5
N-Acetylthiourea	4.65	10	81.7	48.7
S-Methylisothiurea	0	0	51.2	
S-Methylisothiurea	4.65	0	49.6	56.3
S-Methylisothiurea	4.65	10	....	44.5
Thiourea	0	0	54.8	64.5
Thiourea	4.65	0	120.2	125.2
Thiourea	4.65	10	47.8	48.7
Thiouracil	0	0		64.8
Thiouracil	4.65	0		140.9
Thiouracil	4.65	10		57.0
Hydroquinone-Mono- benzylether	0	0		138.4
Hydroquinone-Mono- benzylether	4.65	0		141.2
Hydroquinone-Mono- benzylether	4.65	10		137.1
Control (no antioxidant)	0	0	60.5	55.3
Control (no antioxidant)	4.65	0	63.5	57.3
Control (no antioxidant)	4.65	10	50.3	50.9

in fat, but only in the presence of water and in the absence of copper salts (also of ferric salts, and possibly of other inhibitors of the sulfhydryl radical).

It is improbable that the effect of the copper salt is due to its inherently pro-oxygenic character rather than its effect in blocking the sulfhydryl group. If the former were the case the strong antioxidant, hydroquinone-monobenzylether, should also be inactivated by the copper ion. Such inactivation, however, could not be demonstrated (Table I).

The special interest in the retardation of autoxidation of fats by sulfhydryl compounds lies primarily in the unexpected finding that fats are protected by such antioxidants only in the presence of water. In the second place, this same phenomenon may shed light on the mechanism underlying the hypometabolic state in rats fed certain sulfonamides as well as thiourea and its derivatives.<sup>8, 9, 10</sup> Thiourea and thiouracil have been found to be effective also in thyrotoxicosis in man.<sup>11, 12</sup>

Similar to the effect of sulfhydryl compounds on the enlargement of the thyroid of the rat, there has been found a definite synergism in this respect between p-aminobenzoic acid and sulfonamides<sup>10</sup> as op-

<sup>2</sup> See also K. Hickman, *Ann. Rev. Biochem.*, 12: 353, 1943.

<sup>3</sup> P. György and R. Tomarelli, *Jour. Biol. Chem.*, 147: 515, 1943.

<sup>4</sup> D. F. Clausen, R. H. Barnes and G. O. Burr, *Proc. Soc. Exp. Biol. and Med.*, 53: 176, 1943.

<sup>5</sup> M. B. Williamson—To be published.

<sup>6</sup> See W. R. Fearon, *Brit. Med. Jour.*, 2: 95, 1942.

<sup>7</sup> P. György, R. Tomarelli, R. P. Ostergard and J. B. Brown, *Jour. Exp. Med.*, 76: 413, 1942.

<sup>8</sup> J. B. Mackenzie, C. G. Mackenzie and E. V. McCollum, *SCIENCE*, 94: 518, 1941.

<sup>9</sup> C. G. Mackenzie and J. B. Mackenzie, *Endocrinology*, 32: 185, 1943.

<sup>10</sup> E. B. Astwood, J. Sullivan, A. Bissell and R. Tyslowitz, *Endocrinology*, 32: 210, 1943.

<sup>11</sup> E. B. Astwood, *Jour. Am. Med. Assn.*, 122: 78, 1943.

<sup>12</sup> R. H. Williams and G. B. Bissell, *SCIENCE*, 98: 156, 1943.

posed to their normal antagonism in bacteriostasis. A direct antioxygenic reaction might be the cause for this synergism which hitherto has defied any plausible explanation. The enhancing effect of p-aminobenzoic acid on sulfonamides in the retardation of rancidity in fat has recently been experimentally demonstrated.<sup>13</sup>

More experimental evidence is needed before the link between antioxygenic activity of thiourea and related substances and their effect on metabolism and the thyroid gland can be regarded as established.<sup>13</sup>

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### VITAMIN B<sub>6</sub> DEFICIENCY ANEMIA IN THE DOG<sup>1</sup>

HYPOCHROMIC microcytic anemia typical of vitamin B<sub>6</sub> deficiency in puppies and adult dogs has been produced in this laboratory consistently, thus confirming the work of others.<sup>2,3,4,5,6</sup> The synthetic basic diet used was high in protein and consisted of the following ingredients: casein 40 per cent., sucrose 36, cotton seed oil 18, cod liver oil 2; mineral salts<sup>7</sup> 4 per cent. This diet is essentially free from all members of the vitamin-B complex.

#### EXPERIMENTAL GROUPS

*Group I*—consisting of nine animals—received in addition to the basic diet seven synthetic members of the vitamin B complex as follows: thiamin 1.4 mg,

<sup>13</sup> In preliminary experiments (in collaboration with Dr. R. M. Tomarelli) hydroquinone monobenzyl ether (0.5 per cent. in the diet) has no effect on the size of the thyroid in rats when administered for fourteen days. In this connection it should be noted that the effect of various anti-oxidants depends, to a large extent, on the substrate on which they are tested.

<sup>1</sup> Evidence that vitamin factors found in brewers' yeast in addition to vitamin B<sub>6</sub> are essential for maintaining hemoglobin in the dog.

<sup>2</sup> Only two adult dogs were used, one in Group I, the other in Group III.

<sup>3</sup> P. J. Fouts, O. M. Helmer, S. Lepkovsky, and T. H. Jukes, *Jour. Nutrition*, 16: 197, August, 1938.

<sup>4</sup> P. J. Fouts, O. M. Helmer, and S. Lepkovsky, *Am. Jour. Med. Sci.*, 199: 163, 1940.

<sup>5</sup> H. J. Borson and R. S. Mettler, *Proc. Soc. Expt. Biol. and Med.*, 43: 429, 1940.

<sup>6</sup> J. M. McKibbin, A. E. Schaefer, D. V. Frost and C. A. Elvehjem, *Jour. Biol. Chem.*, 142: 77, 1942.

<sup>7</sup> Mineral salt mixture: Bone meal (steamed), 57.8 per cent.; sodium chloride, 24.4 per cent.; lime stone (oyster shell flour), 12.2 per cent.; iron sulfate (U.S.P.), 3.7 per cent.; magnesium oxide (U.S.P.), 1.2 per cent.; copper sulfate (reagent), 0.3 per cent.; manganese sulfate (reagent), 0.1 per cent.; zinc oxide (reagent), 0.1 per cent.; cobalt carborate, 0.1 per cent.; potassium iodide, 0.1 per cent.

riboflavin 0.7 mg, nicotinic acid 6 mg, inositol 6 mg, pantothenic acid 6 mg, para aminobenzoic acid 6 mg, and choline 30 mg per dog per day, but no vitamin B<sub>6</sub>. All these dogs developed the hypochromic microcytic anemia observed in dogs lacking vitamin B<sub>6</sub>. The initial hemoglobin of these dogs averaged 15.5 grams. This rose to a peak of 18.8 grams in approximately 7 weeks, then declined to values averaging 7.7 grams after 22 weeks on the diet. For other blood values see Table I.

*Group II.* As a control group five puppies were placed on the same régime except that vitamin B<sub>6</sub> was given as a supplement (6 mg per dog per day) from the beginning of the experiment along with the other seven synthetic vitamins. Much to our surprise under these conditions the blood values (determined every two weeks) followed a pattern quite similar to that of the vitamin B<sub>6</sub> deficient animals (Fig. 1). Their initial hemoglobin values averaged 14.5 grams. These rose to a high value of 18.6 grams in 4 weeks, then declined gradually to 9.4 grams over a period of 20 weeks.

*Group III.* As an additional control group, 4 animals (1 adult and 3 puppies) received the basic diet altered to contain brewers' yeast, as a source of all the B-complex vitamins, at a level of 10 per cent., replacing an equivalent amount of carbohydrate. The initial hemoglobin values in this group averaged 14.5 grams, rose to a peak of 19.8 grams after 17 weeks on the diet and then returned to a value around 18 grams, a level which was maintained throughout the rest of the experiment.

*Group IV*—composed of 4 puppies—received the same yeast control diet as group III, but in addition these animals received the eight synthetic vitamins given to group II and in the same daily amounts. Here the average initial hemoglobin was 13.5 grams with a peak averaging 20.5 grams after 21 weeks and a subsequent return to a value around 18 grams. Fig. I illustrates the contrast in behavior between the animals receiving only synthetic vitamins and their yeast controls.

One puppy of group I after being depleted of vitamin B<sub>6</sub> was subsequently treated with vitamin B<sub>6</sub> and later with brewers' yeast. The results substantiated the findings in groups II and III. At the end of the depletion period of 36 weeks this dog had a Hgb. of 6 grams, a red blood count of 4,570,000 and a hematocrit of 18.5 volumes per cent. Treatment with vitamin B<sub>6</sub> resulted in the usual prompt rise in hemoglobin, which increased 4 grams in 6 days with a corresponding rise in the other blood values. The hemoglobin then gradually rose to 15.5 grams in 10 weeks with a corresponding RBC of 6,720,000 and a hematocrit of 41.9. The hemoglobin could not be

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maintained at this level and fell gradually over a period of 6 weeks to 12 grams (RBC 5,580,000, hematocrit 37 vols. per cent.), after which it began to rise under the influence of the yeast treatment. After 13 weeks on this régime a hemoglobin value of 18.5 grams with a red count of 7,500,000 and hematocrit of 46.8

The vitamin B<sub>6</sub> therapy had no discernible effect on the general condition of this dog. The animal weighed 5 kilograms at the beginning of the treatment and at the end of 100 days, or approximately 14 weeks, the weight was exactly the same. There was no improvement in appetite, vitality, condition of the skin, which

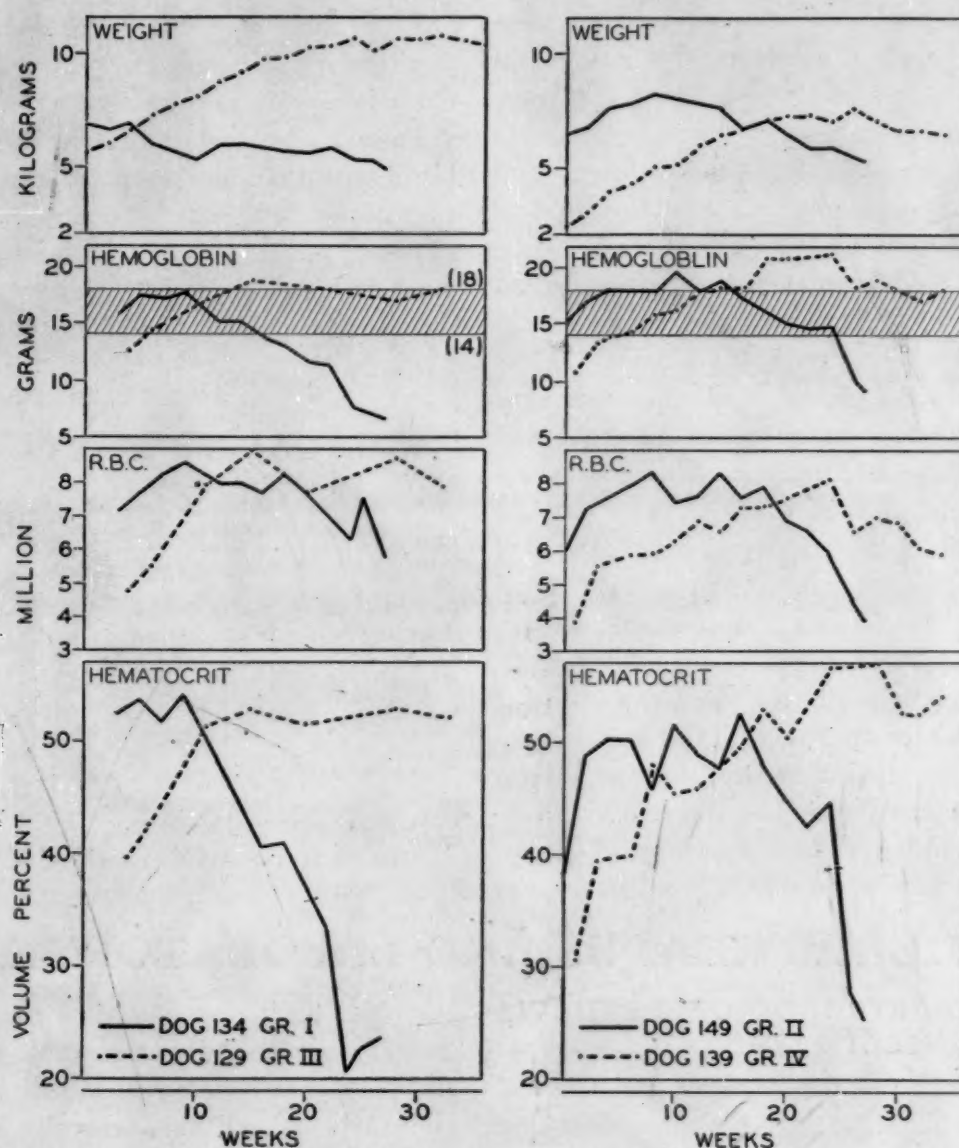


TABLE I

Gr	No dogs	Weeks to peak	Weeks on expt.	Diet	Weight			Hemoglobin			Red count		Hematocrit		
					I	H	F	I	H	F	I	H	F	I	F
					Kilo			grams			million		vol per cent.		
I	9	6	22	BD + (V-B <sub>6</sub> )	5.6	5.8	4.6	15.2	18.8	7.7	6.36	8.36	5.12	47.2	26.5
II	5	4	27	BD + V	4.9	5.9	4.0	14.5	18.6	9.4	5.84	8.16	4.78	40.1	30.9
III	4	15	53	C. D.	5.2	10.6	9.6	14.5	19.7	18.0	5.98	8.92	7.83	39.8	51.6
IV	4	10	36	CD + V	4.5	11.5	11.1	13.5	20.0	19.2	5.36	8.25	7.72	37.8	54.5

I = Initial H = High F = Final

vols. per cent. was obtained. The peak values were reached after 19 weeks on the yeast diet and were maintained for 14 weeks, the hemoglobin not falling below 20 grams during this time. After that the hemoglobin fell slightly and was maintained at approximately 18 grams throughout the remainder of the treatment period of one year.

had a severe fungus infection, or the general alopecia. The effect of the yeast treatment on the general condition of the animal as well as the hematologic changes in the blood elements was almost miraculous. In 16 weeks the dog had doubled its weight, and almost doubled its hemoglobin and hematocrit, completely cleared up the fungus infection and grown a sleek

healthy coat over areas that appeared miserably "moth eaten" at the time the treatment started. The changes in this animal served as a dramatic illustration of the importance of administering the entire B complex which is to be found only in natural sources.

Although vitamin B<sub>6</sub> therapy in the case of a dog with vitamin B<sub>6</sub> deficiency anemia produces a dramatic and apparently specific effect, yet it has been observed that B<sub>6</sub> alone will not bring the hemoglobin back to normal. Borson and Mettler<sup>5</sup> found that some of the filtrate factors were needed for more complete blood regeneration in their B<sub>6</sub> deficient dogs, and McKibbin and his associates<sup>6</sup> found that certain factors present in liver were needed before normal hemoglobin values ("13-14" grams) could be reached in their deficient animals. This was also borne out in Wintrobe's study<sup>8</sup> with vitamin B<sub>6</sub> deficient swine. In the present study the giving of all the other synthetic B-complex factors in adequate amounts was sufficient to enable the addition of vitamin B<sub>6</sub> alone to bring the hemoglobin back to 15.5 grams but not to maintain it at this level. Brewers' yeast at a level of 10 per cent. not only maintained the hemoglobin level but kept it at a constant value considerably higher than the accepted normal of 14.0 grams.<sup>9</sup> These extremely high values in the yeast-treated dogs, i.e., 18-20 grams, as compared with 14 grams were viewed with some scepticism at first, but they have been repeatedly confirmed when checked in other laboratories of this hospital. The observance of hemo-

globin values from 4-5 grams higher than those usually found in dogs probably reflects the fact that dogs under natural conditions of living never receive an optimum supply of the vitamin-B complex. It is not urged that this is essential, but it is probably of value in situations not fully understood at the present moment.

From these data it is concluded that even though a diet lacking vitamin B<sub>6</sub> results in a typical hypochromic anemia in dogs which responds specifically to vitamin B<sub>6</sub> treatment, vitamin B<sub>6</sub> alone or even combined with the known synthetic factors of the B complex is not sufficient to maintain the hemoglobin at optimum levels. There is at least one factor, possibly more, in brewers' yeast in addition to vitamin B<sub>6</sub> which serves to stimulate hemoglobin production in the dog.

#### ACKNOWLEDGMENTS

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## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### TECHNIQUE FOR STROBOSCOPIC STUDIES OF INSECT FLIGHT<sup>1</sup>

SINCE the application of the Edgerton stroboscope<sup>2</sup> to studies of insect flight,<sup>3,4</sup> it has become clear that the frequency of wing-beat of standardized insects offers a rigorous technique in quantitative biology. There is reason to believe that the usefulness of such measurements will not be limited to studies of insect physiology, but may extend into other fields such as genetics and experimental pharmacology. It is therefore our purpose to describe the apparatus and technique that we have found most suitable for determining wing-beat frequency.

A survey of the flight of numerous insects has dem-

<sup>8</sup> M. M. Wintrobe, R. H. Follis, Jr., M. H. Miller, H. J. Stein, R. Alcayaga, S. Humphreys, A. Suksta and G. E. Cartwright, *Bull. Johns Hopkins Hosp.*, 72: 1, 1943.

<sup>9</sup> R. F. Scarborough, *Yale Jour. Biol. and Med.*, 3: 359, 1931.

<sup>1</sup> This study was aided by a grant from the Josiah Macy Junior Foundation.

<sup>2</sup> K. J. Germeshausen and H. E. Edgerton, *Electronics*, 10: 2, February, 1937.

<sup>3</sup> L. E. Chadwick, *Psyche*, 46: 1-8, 1939.

<sup>4</sup> L. E. Chadwick, *Physiol. Zool.*, 12: 151-160, 1939.

onstrated that *Drosophila* is a most favorable experimental animal. Advantages offered by this genus include the year-round availability of numerous species and varieties and the generally consistent response under the experimental conditions, as well as the large body of information which already exists in regard to their structure and physiology. Furthermore, wing-beat frequency varies not only with the age and sex of the individual<sup>5</sup> but also with the temperature at which they are reared and flown,<sup>6</sup> so that these factors must be carefully controlled. The use of homogeneous, inbred strains is also highly desirable.<sup>6</sup> Procedures for regulating these details are better established and more easily applied for *Drosophila* than for most other insects. While the small size of *Drosophila* may be a hindrance in some types of work, as in analysis of chemical changes during flight, it simplifies the problem of mounting specimens for observation of wing movement. The relatively stiff

<sup>5</sup> C. M. Williams, L. A. Barnes and W. H. Sawyer, *Biol. Bull.*, 84: 263-272, 1943.

<sup>6</sup> S. C. Reed, C. M. Williams and L. E. Chadwick, *Genetics*, 27: 349-361, 1942.

articulation between abdomen and thorax in this genus is also helpful in this respect. *Drosophila* thus seems particularly suitable for measurement of wing-beat frequency; however, the technique described below can be applied with minor modifications to a variety of other insects.

The specimens are fastened as indicated in Fig. 1. A series of mounts are prepared, each of which consists of a short length of copper wire soldered at one end to a pin (head removed) and glued at the other end to a narrow strip of paraffined paper. The insects are lightly etherized and further manipulations are carried out under a dissecting microscope. By means of a scalpel the hind pair of legs are removed at the femoro-tibial joint in order to prevent their touching the mount and inhibiting flight. This operation has no demonstrable effect on wing movement. Next the

Due to the tarsal reflex,<sup>7</sup> flight is stimulated by withdrawal of the platform and inhibited by its return, so that it may be controlled at the will of the operator.

The chamber, which consists of a length of Pyrex combustion tubing, is sealed by clamping it between brass end-pieces connected by three rods. The triangular end-pieces are machined to receive the ends of the chamber and fitted with rubber gaskets. With this arrangement the chamber may be made tight for pressures as high as ten atmospheres. The desired gas mixtures are supplied and pressures controlled through copper tubing provided with suitable valves and sealed into the central openings of the brass end-pieces.

Since accurate control of the temperature of the chamber is essential, the apparatus is most advantageously immersed in a water bath that is thermostati-

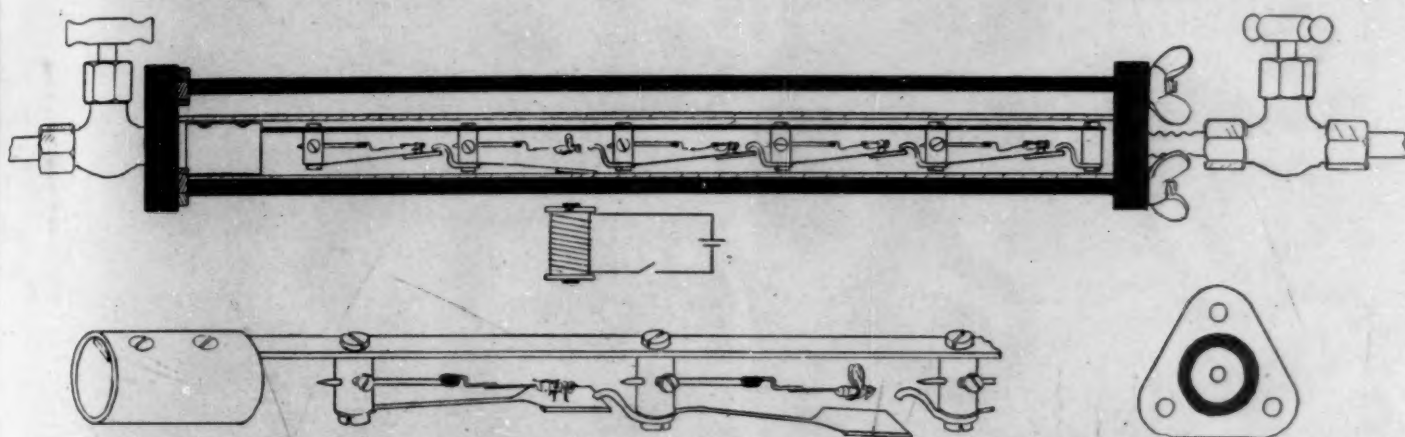


Fig. 1. Profile view of flight chamber ( $\times \frac{1}{2}$ ), details of brass fitting and internal view of brass end-piece.

specimen is placed belly-down on a piece of cork and the wings spread by means of a forked pin placed behind their margins. A dissecting needle with a short piece of resistance wire wrapped around its shaft is warmed electrically and used to fuse the paraffined tip of the mount carefully to the dorsal end of the abdomen. The insect is not damaged by this process and regains its flight abilities within a few minutes. After half an hour it is fully recovered from the anesthetic and ready for testing.

As diagrammed in Fig. 1, the mounted insects are fastened to a brass fitting that slides snugly into the Pyrex tube which serves as an experimental chamber. It is advantageous to enclose a number of individuals in the chamber in order to equilibrate them simultaneously with the conditions that are being tested. Each mount is fastened in place with a set screw and adjusted, by bending the copper wire so that the specimen stands on the corresponding spring platform. These springs consist of phosphor-bronze, 0.15 mm thick, cut to appropriate shape and soldered at their free ends to thin squares of soft iron. After the chamber has been sealed, the springs may be depressed by an electro-magnet placed outside the apparatus.

cally regulated. We have found most convenient for this purpose a bath equipped with a glass-bottom offset. A mirror placed outside the bath and beneath the offset permits the animals to be studied in silhouette against the stroboscopic lamp clamped above the water surface. An extension cord leads from the lamp and reflector unit to the control box on the table below. The flight chamber is supported by a clamp so that it can be lifted from the water or moved longitudinally in front of the water-tight electromagnet, and is so oriented that the dorso-ventral axis of the animals lies in the horizontal plane. Thus, by moving the chamber, each animal can be brought opposite the magnet and tested in turn, while it is viewed through the glass offset without obstruction. The flight response of the animals does not seem to be influenced in any way by their static orientation in respect to the field of gravity. If the animals are to be studied during continuous flight, a permanent magnet may be substituted in place of the electromagnet.

By means of an apparatus thus arranged, it has been possible to measure precisely the frequency of

<sup>7</sup> G. Fraenkel, *Ztschr. f. Vergleich. Physiol.*, 16: 370-393, 1932.

wing-beat under a variety of experimental conditions. Many hundreds of reliable measurements may be accomplished on each individual during intermittent flights having durations of 3 to 5 seconds, separated by adequate periods of rest (about 20 seconds). Under carefully controlled conditions the variability of such determinations on a single individual is generally less than one per cent. For 24 strains of *Drosophila* the coefficient of variability among different individuals of single strains was found to average 3.10 per cent.<sup>6</sup> Useful information in regard to metabolism and fatigue can be obtained in terms of the progressive changes in wing-beat frequency during continuous flight.<sup>5</sup> The principle of the apparatus has also been adapted for measurements correlating wing-beat frequency with respiratory exchange.<sup>8</sup>

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#### THE COAGULUM-CONTACT TECHNIC IN TRAUMATIC RUPTURE OF THE LIVER IN DOG AND MAN

At the suggestion of Dr. W. Wayne Babcock, it was decided to extend the principles involved in the coagulum-contact technic of skin grafting<sup>1</sup> to the control of bleeding and the promotion of healing in traumatic injuries of the liver and spleen. In the past it has been customary to sew the opposing surfaces of the liver together. This frequently promotes rather than controls bleeding. Likewise the packing of the injured field is often complicated by bleeding at the time the packing is removed. The new method presents neither of these difficulties.

Equal quantities of plasma and cell extract (autogenous, homologous or heterogenous) are mixed together just before using. The bleeding surfaces of the liver which are to be joined are exposed and the mixture is rapidly brushed over both surfaces with a sterile camel hair brush. The surfaces are firmly held together for about three minutes. They are then released and will adhere firmly to one another. If the bleeding is still present in poorly apposed parts, some of the mixture is brushed over these areas and left to coagulate. If there is profuse bleeding the brush may

<sup>8</sup> L. E. Chadwick and D. Gilmour, *Physiol. Zool.*, 13: 398-410, 1940.

<sup>1</sup> M. E. Sano, *Am. Jour. Surg.*, lxi, 105-106, 1943. This new method of skin grafting using plasma and cell extract to form an adhesive and growth-stimulating coagulum is being used not only at Temple University Hospital but at other hospitals with very good results.

be held over the site of bleeding for one to two minutes. On microscopic examination, three days later, fibroblasts are seen to have proliferated in the coagulum formed. Five days after operation, small sinuses appear in certain sections. By the end of ten days, it is often difficult to find the line of incision on gross inspection of the specimen. Microscopically, one finds these areas well organized with very little evidence of damage to the adjacent liver cells.

Damaged surfaces of liver will adhere to one another on pressure without the interposition of plasma and extract. However, oozing does not stop so readily and when profuse bleeding occurs at the inner angle of two opposed surfaces where it is difficult to exert pressure, it is almost impossible to stop the bleeding by pressure alone. While adhesion has been 100 per cent. when using the plasma-extract mixture on fifteen dog livers and one human liver, the liver in three (or 20 per cent. of the cases) had to be restuck when no plasma-extract was used. In no case did the dog bleed to death with either method.

Similar experiments have been carried out on the spleens of dogs. Here the plasma extract gives definitely superior results but neither method is as satisfactory as in the liver. Due to the intrinsic structure of the spleen itself, infarctions are apt to occur. Again, no death actually occurred due to hemorrhage but healing was slow and unsatisfactory.

This new method is extremely simple and uses the physiologic principles of blood clotting and wound healing thus eliminating any extraneous factors which might complicate and endanger the individual's life in some other way. It is hoped that this method may be of use in the treatment of war wounds.

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